DRILLING MANUAL
(METRIC VERSION)

SEPTEMBER, 1994

This document has been modified to conform with the Department's directive to convert all manuals and operations to metric units by 1995.

Dimensions of drilling tools and equipment were "soft" (exact) converted in accordance with the DCDMA technical manual. Please note that these dimensions are the metric measurements of the tool sizes standardized by the DCDMA using the "inch standard". The dimensions are **not** the same as those using the DCDMA "metric system", which was developed in Europe.

Other dimensions which are not associated with equipment or hardware were "hard" (approximate) converted. For example, a sampling interval of 5 feet was converted to 1.5 m, and not 1.524 m, which is the "soft" conversion.

This document should be viewed as a working draft. Any questions or comments should be directed to the Soil Mechanics Bureau's Drilling and Subsurface Exploration Section.

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DRILLING INSTRUCTIONS FOR REGIONAL FORCES

DESCRIPTION. This work shall consist of drilling for soil and rock samples, and recording boring log data in accordance with these instructions.

Boring Logs. The borings logs will have the following information typed into the computer database:

- Project Identification Number (PIN)
- Project Name
- Boring Location by Station and Offset and Coordinates
- Date Start and Finish
- Hole Number
- Surface Elevation at Boring Location
- Weight and Fall of Hammer (Casing)
- Weight and Fall of Hammer (Sampler)
- Casing and Sampler Size
- Regional Soils Engineer
- Structure Name/Number
- Penetration Records (Blows on Casing, Drive Pipe and Sampler)
- Groundwater Data
    - Depth at which drill water was first used
    - Depth at which groundwater was first encountered
    - Depth to groundwater at the beginning and end of each day's operation
- Rock Core
    - Length of Run
    - Percent Recovery
    - Number of Pieces
    - Depth Core Obtained
    - Size of Core Obtained
    - Type of Core Barrel

Groundwater Determinations. The level at which groundwater is first encountered in the borings shall be noted. Water level readings shall be taken at the end of each day, after the last sample has been taken and the sampler and rods have been

removed. Do not fill the casing with water (as was previous practice), unless there is a need to compensate for a condition such as running sand. Measure and record the change in water level when resuming work. Capped borings shall be vented. Groundwater levels shall be measured before and after the casing or drive pipe is pulled. Each water level reading should be recorded showing the date and time the reading was made, the depth of the drive pipe or casing, and the depth to water. Any loss or gain of water in the boring, except that caused by deliberately introducing water and/or inserting or removing tools, shall be recorded. This record shall show the date and time the loss or gain is noted, the depth of the casing and the depth to water. The height of any artesian rise shall be recorded.

All water level readings and related data shall be recorded on the boring logs under "Remarks", or SM208 chart. If necessary, additional forms shall be used for recording groundwater data.

Artesian pressures shall be permanently sealed at the elevation at which they were encountered. No pipe or casing shall be removed from the hole until the SMB has been contacted. SMB personnel will supervise the sealing of all artesian flow conditions.

Split Barrel Samples.

Progressing the Hole. The hole shall be progressed by driving flush-joint casing, flush-coupled casing, extra-strength drive pipe when requested, by drilling casing, or, where permitted, by a drilling mud process or by using a hollow flight auger. A 136.3 kg (± 3 percent) hammer falling freely 450 mm shall be used to drive casing or drive pipe. Drag bits or roller bits may be used to make a hole ahead of the casing to reduce casing blow counts in compact or bony soil conditions. Drag bits or roller bits used for this purpose shall come no closer than 300 mm from the sampling elevation.

Casing refusal shall be considered as 300 blows for less than 300 mm of penetration. When refusal is encountered, the casing shall be cleaned and coring will commence.

Prior to sampling, the drill hole shall be cleaned to the sampling elevation by using equipment that will not disturb the material to be sampled. Bottom discharge bits, including samplers, will not be allowed. "N" size drill rods or larger shall be used in 76 mm or larger inside diameter casing.

Sampling. Samples shall be taken at every change is stratum but in no case at intervals greater than 1.5 m. Continuous sampling may be directed by the Regional Soils Engineer. The sampler shall be placed on the bottom of the cleaned out hole and then driven 450 mm, with a 136.3 kg (± 3 percent) hammer falling freely 450 mm. The number of blows required to drive the sampler each increment of 150 mm shall be recorded. If refusal is encountered before the desired sample length is attained, the sampler shall be removed from the hole and core drilling started. Sampler refusal shall be 50 hammer blows for less than 150 mm of penetration.

When a recovery of less than 150 mm of sample in a split barrel sampler is retrieved, the sampler shall be redriven at the same elevation in an attempt to obtain more material. Only the first set of blows shall be recorded on the boring log, but a note shall be included under remarks indicating that a second sampling attempt was made. A basket or other spring type retainer may be used on any or all sampling attempts. Flap or trap valves will only be used when specifically directed by the Regional Soils Engineer. When sampling material below the water table, the hole shall be kept full of fluid during the removal of tools to prevent flowback unless otherwise directed by the Regional Soils Engineer.

Marking and Packaging. Samples shall be placed in tied plastic storage bags placed in jars in such a manner so as to maintain the natural structure of the sample. The jar shall be labeled to show the project name, PIN, sample number, hole number, the depth from which the sample was taken, and any remarks that might pertain to that sample. Jars shall be placed in cartons. Samples must be protected from freezing or extreme heat.

Thin-Walled Tube Samples.

Progressing the Hole. The hole shall be a minimum of 100 mm in diameter. Drilling mud may be used if permitted by the Regional Soils Engineer. Hollow stem augers

will not be allowed. The hole shall be cleaned using methods and equipment which will not disturb the soil to be sampled. Bottom discharge bits, including samplers, will not be allowed as cleanout tools.

The 60 mm of soil directly above the sampling elevation shall be removed with a cleanout jet auger without the use of water. "N" size drill rods or larger shall be used.

Sampling. Thin-walled tube samples shall be taken in the strata designated by the Regional Soils Engineer. Samples shall be recovered with a stationary piston type sampler or a hydraulically operated piston sampler, modified to accept the thin-walled tubes. Samplers with piston rods extending to the ground surface must be provided with clamps which positively lock the piston against upward travel while lowering the sampler to the sampling depth. During the press the piston rods shall be locked in a stationary position to eliminate any movements either up or down. In addition, the sampler shall also be provided with positive locks to secure the piston rods prior to removal of the sampler after penetration.

At the elevation to be sampled, the tube shall be pressed into the soil with a continuous motion a distance of 450 mm. Care must be taken to allow air and water to flow freely through the vent thus preventing compression of the soil sample. After pressing to the required depth and waiting for 5 minutes, the sampler shall be carefully rotated and removed from the hole.

During the removal of the sampler the hole shall be kept full of fluid. Before the thin-walled tube is removed from the piston, the piston rod shall be backed off to admit air past the flattened threads to break the vacuum. For other approved types of equipment, the necessary vacuum breaking measures shall be taken. The length of sample in the tube and also the distance pressed, shall be measured, recorded and indicated on the tube label.

Should a thin-walled sample not be retained, a 90 mm driven sample with liner shall be taken.

The bottom of the sample shall be carefully squared off at least 25 mm back from the

end of the tube and a wax seal, approximately 25 mm thick, shall be poured in the bottom end of the tube. The soil at the top of the tube shall be carefully squared off and a wax seal, approximately 25 mm thick, shall be poured. Any space remaining between the top or bottom of the sample tube shall be filled with sawdust or paper after the wax has hardened. The ends of the tubes shall be sealed with snugly fitting plastic caps which shall be secured in place with friction tape. Wax shall be not be placed on the outside of the tube. Labels shall be placed on the tube below center and secured with strips of tape.

Marking, Packaging and Transporting Samples. Thin-walled tubes shall be labeled to show the Project Identification Number, Location, hole number, sample number, amount pressed, amount recovered, depths from which the sample was taken, and any remarks that might pertain to that sample. The samples shall be handled, stored and transported using care to prevent the samples from being subjected to freezing, drying, jarring and any other disturbance. The tubes properly packaged shall be stored and transported in an upright position at all times.

Rock Core Samples.

Progressing the Hole. The hole shall be progressed through the overburden until refusal is encountered. Continuous core drilling shall then be progressed in boulders and ledge rock at locations and to depths determined by the Regional Soils Engineer.

Sampling. Core shall be drilled using a double tube, swivel type core barrel. If at any time the core barrel is withdrawn more than 30 mm the core barrel shall be removed from the hole and the core removed from the barrel.

Marking and Packaging. Rock cores shall be labeled in accordance with the Soil Mechanics Bureau Drawing entitled "Instructions for Labeling Rock Cores" currently in effect.

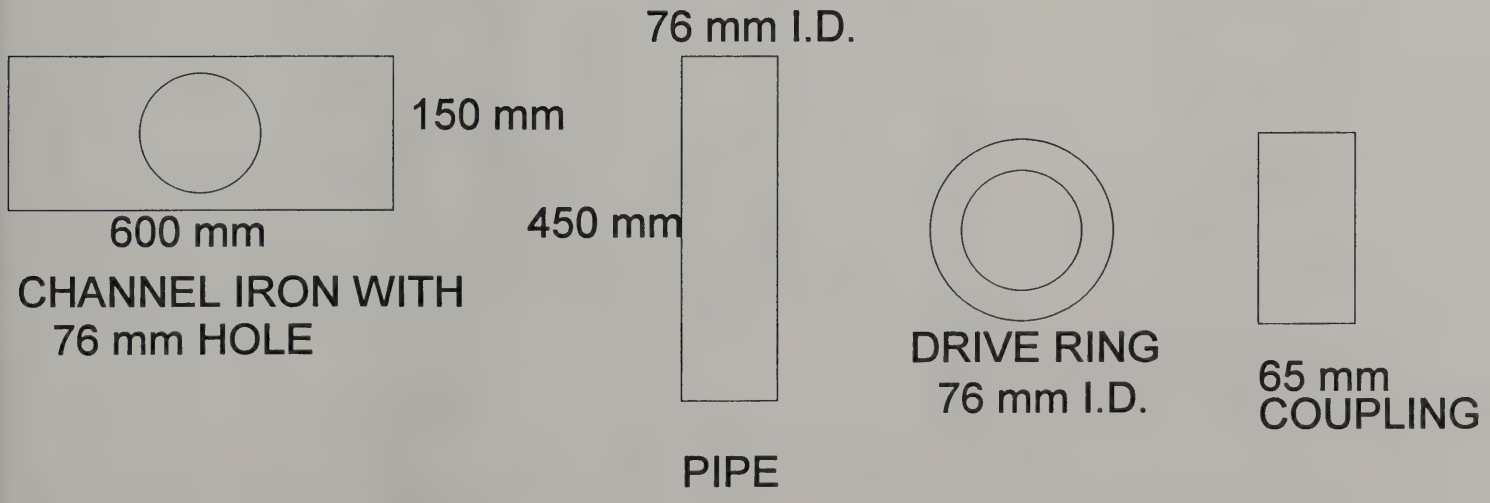
Rock core recoveries of less than 85 percent of each run will be considered unacceptable and coring shall continue for another 1.5 m run, unless in the judgment of the Regional Soils Engineer, the necessary information has been obtained.

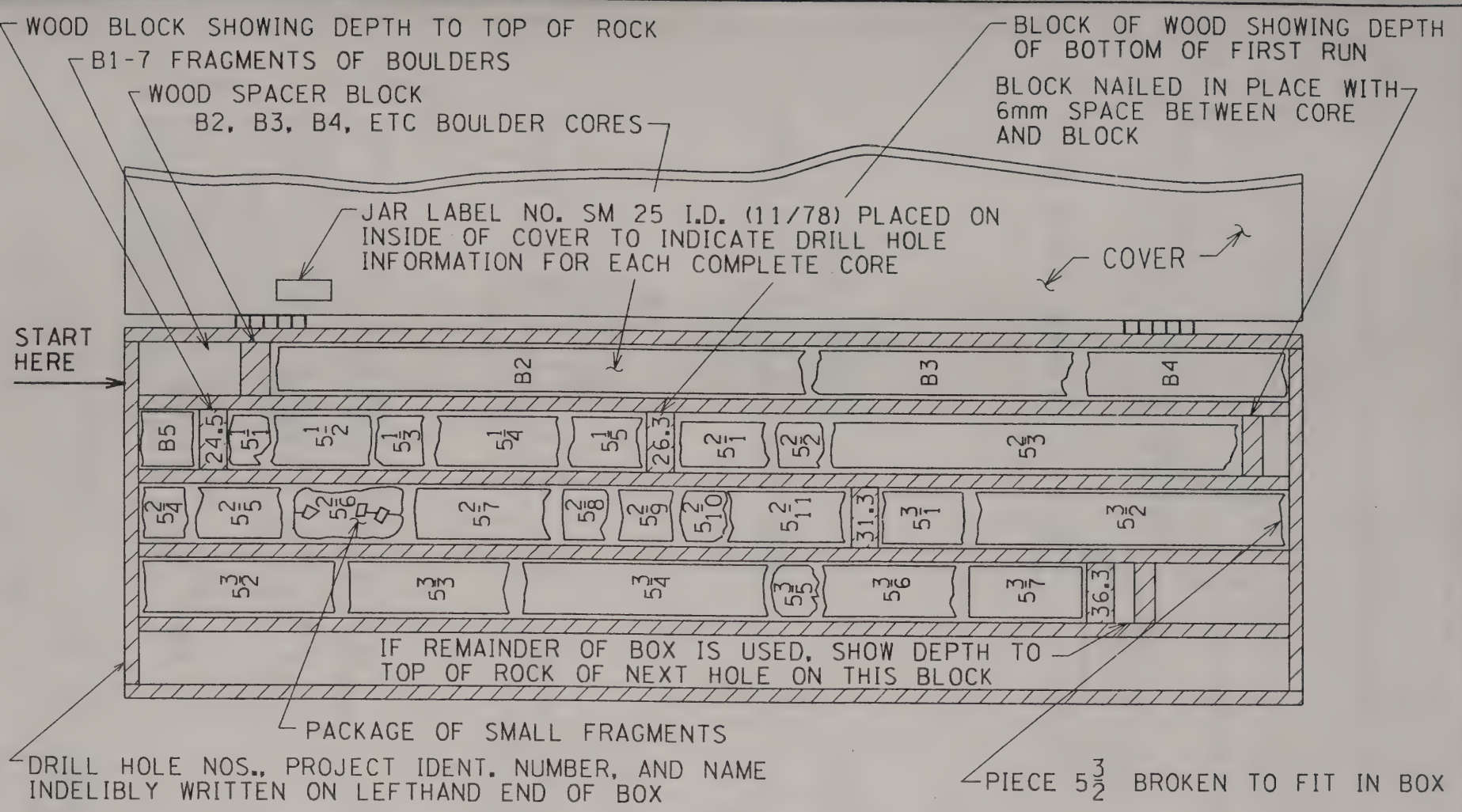
DRILLING A DRILL HOLE DRY

STEVENS PIPE HOLDER

1. Drive the pipe down to 1.5 m, then bump the pipe back so that 0.6 m is above ground.
2. Slip 150 mm x 600 mm channel iron over pipe to ground.
3. Slip a 76 mm I.D. x 450 mm pipe over 65 mm pipe.
4. Install a 76 mm drive ring and 65 mm coupling to hold pipe
5. Drive sampler down to -1.5 m from ground elevation.
6. Sample at 1.5 m.

Repeat operation each time a sample is needed.





NOT TO SCALE

NOTES:

HOLE NUMBER - $5\frac{1}{5}$ - $\frac{1}{5}$ - RUN NUMBER
5 - PIECE NUMBER

IF CORE FROM MORE THAN ONE DRILL HOLE IS PLACED IN THE SAME BOX, THE BOX MUST BE CAPABLE OF ACCEPTING THE COMPLETE CORE. CORE FROM ANY ONE DRILL HOLE SHALL NOT BE STORED IN MORE THAN ONE BOX

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DIRECTOR
SOIL MECHANICS BUREAU

REGION NO. MO

COUNTY

DWG. NO. MO SM 1693 R5

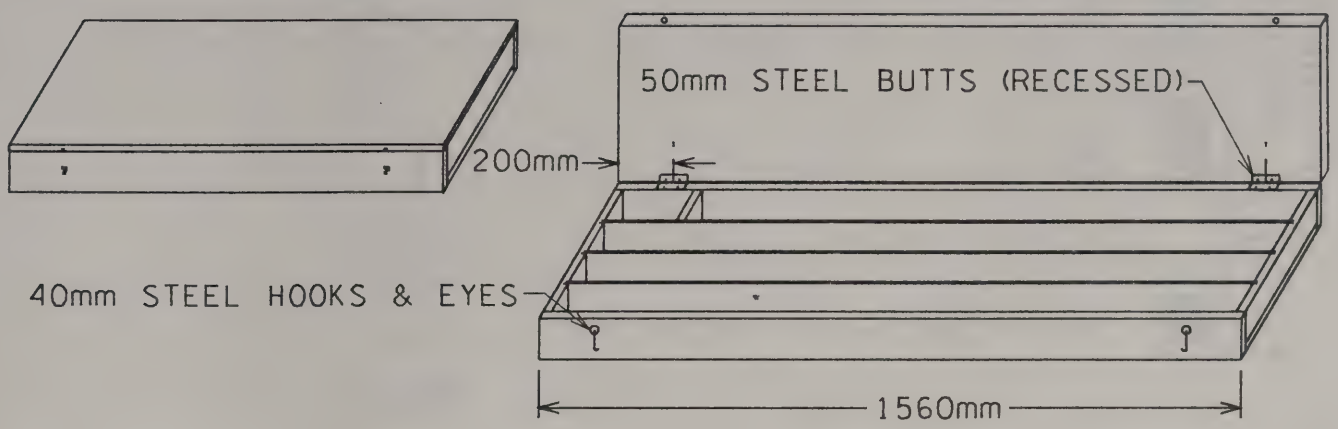
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
TECHNICAL SERVICES DIVISION

PROPER LABELING OF ROCK CORES
N.Y.S.D.O.T. BUREAU OF SOIL MECHANICS

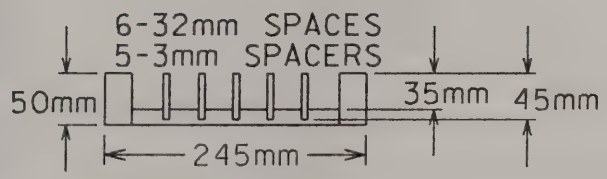
REVISED ENGLISH TO METRIC 3-18-94

CLOSED VIEW

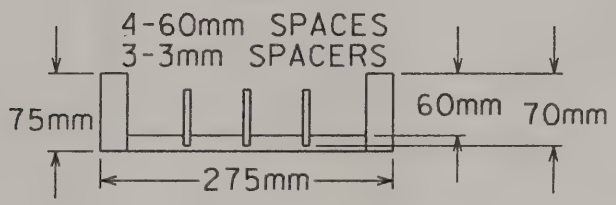
OPEN VIEW



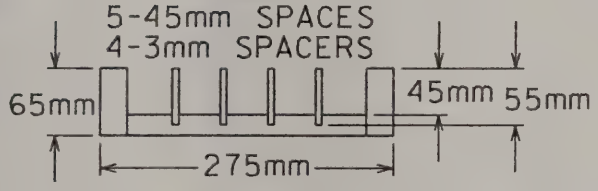
AX



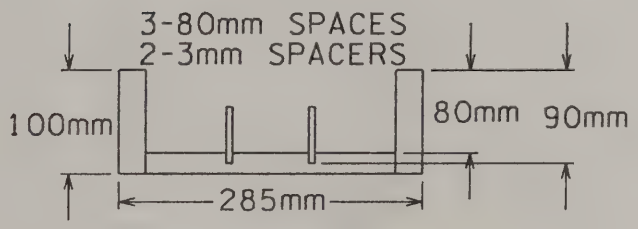
NX



BX



HX



NOTES:

1) BOXES TO BE ASSEMBLED WITH VARNISH OR CEMENT COATED NAILS AT EACH CORNER.
2) SPACERS TO BE 3 mm TEMPERED HARD-BOARD OR EQUAL RECESSED AT ENDS AS WELL AS BOTTOM AND FASTENED WITH WATERPROOF GLUE.
3) ALL WOOD TO BE WHITE PINE GRADE NO. 2 COMMON OR BETTER, 25mm THICK, (FINISHED 20 mm), COATED WITH WOOD PRESERVATIVE.

NOT TO SCALE

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CORE BOX
AX, BX, NX, AND HX SIZES

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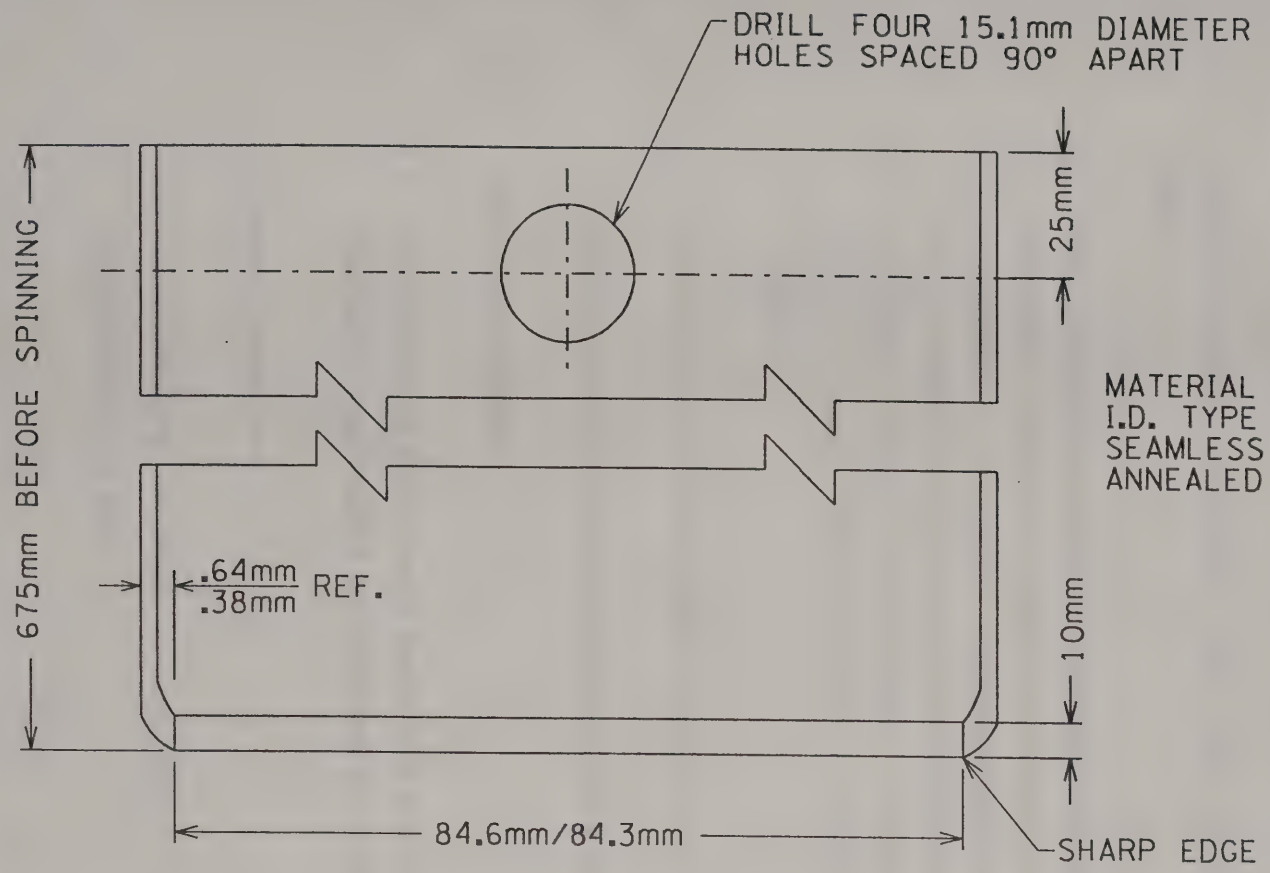

MATERIAL 88.9mm O.D. X 85.6mm/85.3mm I.D. TYPE 304 STAINLESS STEEL TUBING, SEAMLESS OR WELDED, COLD DRAWN ANNEALED AND PICKLED.

HALF SECTION

NOT TO SCALE

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STAINLESS TUBE FOR 90mm UNDISTURBED SOIL SAMPLES

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GROUNDWATER READINGS

Accurate groundwater level readings are an important part of the data obtained from subsurface explorations.

The following procedures during progression of drill holes will assist in obtaining accurate groundwater levels. Where more accurate levels are not obtainable during the drilling period, extended water level readings should be considered or may be required. It should be understood that the procedures are guidelines, and may be adjusted in the field to obtain the best information possible.

A. Permeable gravelly and sandy soils, and slowly permeable silty and clayey soils.

1. Measure and record depth to water and corresponding casing depth at the beginning and end of each day during the time the boring is being progressed. Do not fill the casing with water at the end of the day. Groundwater readings are more accurate when the water is allowed to rise overnight. There will, of course, be exceptions to this requirement, such as when a head of water is needed to stabilize a flowing sand condition.

2. Show date, time, water and casing depth for each reading on the log.

3. Indicate depth at which wash water was introduced into the boring.

B. Loss of wash water.

1. The depth at which wash water was lost or return flow decreased when coring in rock should be recorded on the log.

C. Artesian pressures.

1. The elevation or depth of the source of artesian pressure must be recorded on the log.

2. The maximum artesian pressure or head must be measured and recorded on the log.

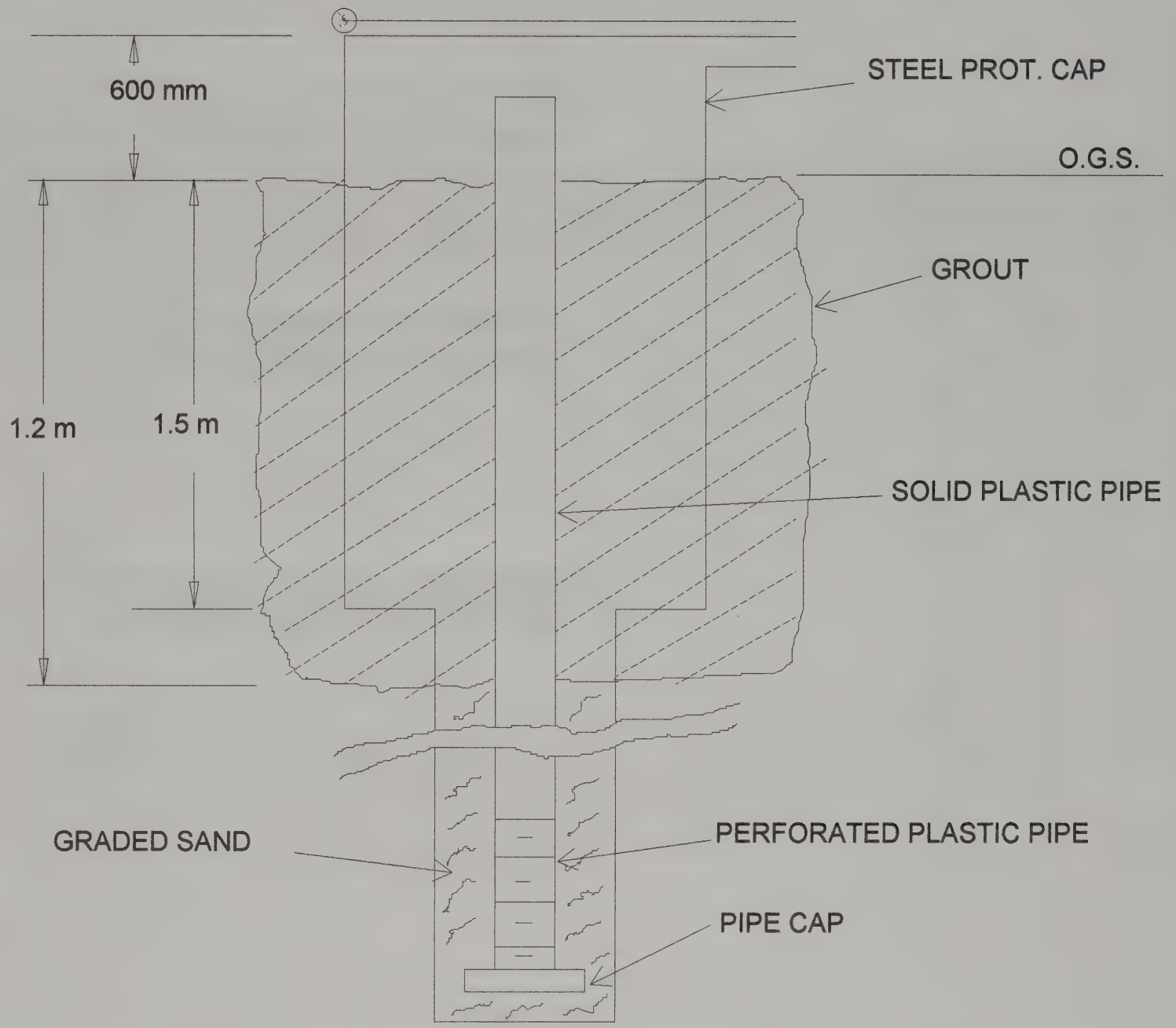
3. The Regional Soils Engineer must be notified as soon as possible after artesian pressures are encountered.

4. The Regional Soils engineer shall notify the Soil Mechanics Bureau of each occurrence of artesian pressure before the drill rig is moved off the hole.

5. No casing is to be removed until the Soil Mechanics Bureau has been contacted.

6. Casing shall not be removed from the hole until the artesian flow is stopped.

TYPICAL WATER OBSERVATION WELL INSTALLATION

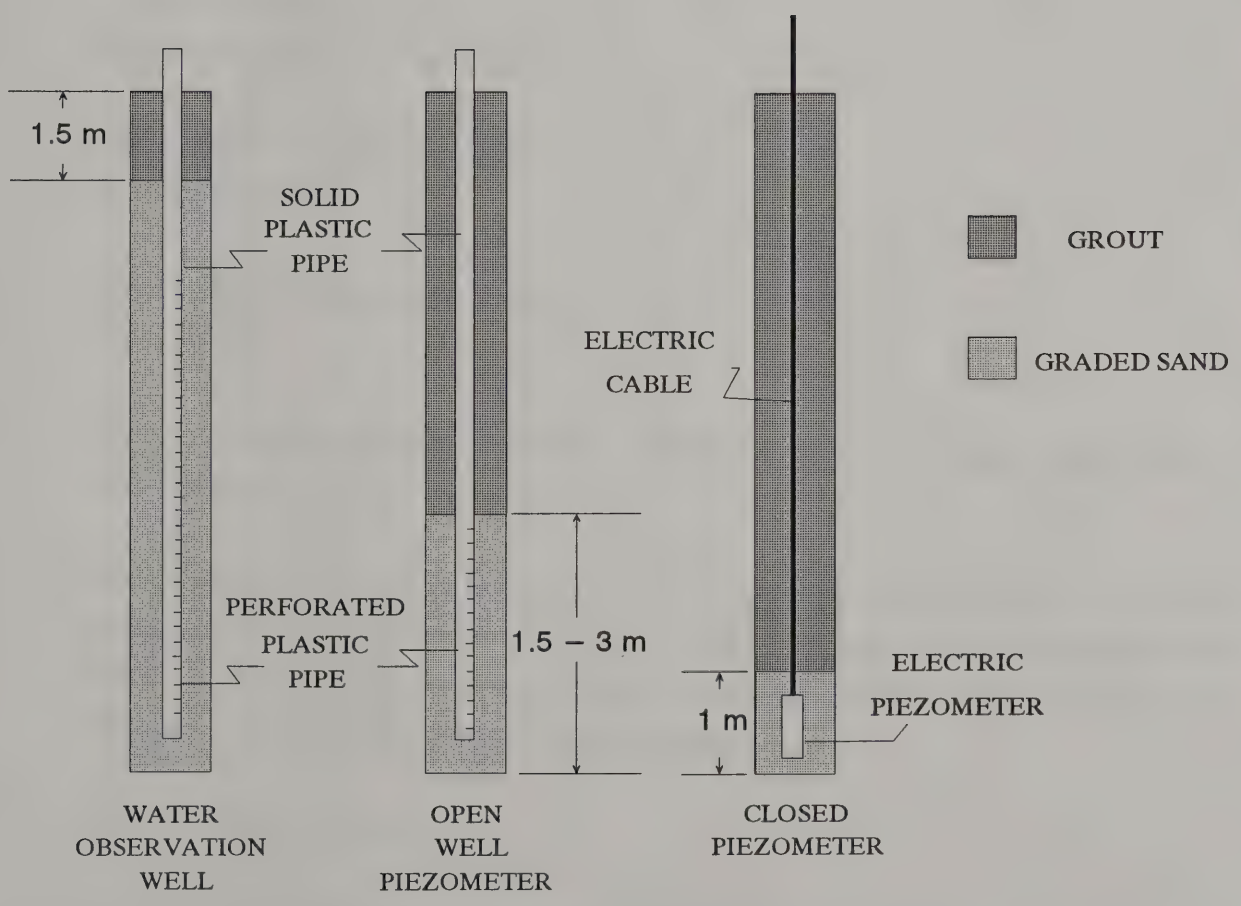


PERMANENT GROUNDWATER GAGES

1. Unless otherwise specified, all installations are Water Observation Wells.

2. If artesian is encounterd or a special request is made, Open Well Piezometers are used.

3. On rare occasions, Closed Piezometers are installed. A representative from the Soil Mechanics Bureau in Albany will assist.



DIAMOND BITS

In order to provide an adequate number of diamond bits for each Regional Soils Section the following maximum distribution shall be adopted.

1. "AX" Coring
   Two per crew (any combination of low, medium or high count) plus two in stock.

2. "NX" Coring
   One per crew plus two in stock.

3. "AXM" Coring
   One per crew plus one in stock.

4. "NXM" Coring
   One per crew plus one in stock.

5. "NX"/"NW" Casing Shoe Bits
   Two per region.

6. "BX"/"BW" Casing Shoe Bits
   Same as #5.

7. Above quantities may include any combination of coarse, fine, extra fine, or impregnated.

8. Quantities of bits in categories 5 and 6 may be increased for particular projects. These additional quantities will be furnished by the Soil Mechanics Bureau. The additional bits are to be returned with the completed bit report within two weeks after completion of project.

9. "HW" Casing Shoe Bits

   These will be issued when needed for particular projects. They are to be

returned with the completed bit report to the Soil Mechanics Bureau as soon as the work is completed.

10. Method of Bit Replacement

A. Bits to be replaced are to be mailed, delivered or sent by courier to the Soil Mechanics Bureau. Two copies of the completed bit report (Form SM92R2) are to accompany each bit.

B. Bits will be replaced in kind or as specified on report (Specify impregnated, coarse, fine or extra fine according to needs).

C. Delays will be encountered in receiving bits if the bit report is not completely filled out, including P.I.N. number and date out of service.

DRIVE PIPE

	SIZE	I.D.	O.D.
X	65 mm	58.7 mm	73.0 mm
X	100 mm	96.8 mm	114.3 mm

DIAMOND CORING BITS

		NOMINAL (mm)		SET SIZE (mm)	
	SIZE	O.D.	I.D.	O.D.	I.D.
	RWT	29.4	19.1	29.5	18.7
	EWT	38.1	23.0	37.3	23.0
	EWG, EWM	38.1	20.6	37.3	21.5
	AWT	47.6	32.5	47.6	32.5
X	AWG, AWM	47.6	30.2	47.6	30.1
	BWT	60.3	44.5	59.6	44.5
X	BWG, BWM	60.3	41.3	59.6	42.0
	NWT	76.2	58.7	75.3	58.8
X	NWG, NWM	76.2	54.0	75.3	54.7
	HWT	99.2	81.0	98.8	80.9
X	HWG	99.2	76.2	98.8	76.2
	70 mm x 98.4 mm	98.4	69.9	97.5	68.3
	100 mm x 140 mm	139.7	101.6	138.0	100.8
	152 mm x 197 mm	196.9	152.4	194.4	151.6
	AXWL S&H	47.6	25.4	47.6	25.4
	BXWL S&H	60.3	36.5	59.6	36.5
	NXWL s&H	76.2	49.2	75.3	49.2
	HXWL S&H	95.3	63.5	95.8	63.6
	PXWL S&H	122.2	84.9	122.0	85.0

FLUSH JOINT CASING

	SIZE	WT. Kg/m	O.D. mm	I.D. mm
	RW	2.7	36.5	30.2
	EW	4.2	46.0	38.1
	AW	5.9	57.2	48.4
X	BW	10.4	73.0	60.3
X	NW	12.9	88.9	76.2
X	HW	16.8	114.3	101.6
	PW	20.8	139.7	127.0
	SW	23.7	168.3	152.4
	UW	38.6	193.7	177.8
	ZW	43.0	219.1	203.2

S&H WIRE LINE DRILL RODS

SIZE	WT. Kg/m	O.D. mm	I.D. mm
AX	4.5	44.5	35.7
BX	5.9	57.2	48.4
NX	7.9	71.4	61.9
HX	11.4	88.9	77.8
PX *	26.7	114.3	103.2

* PX Rod Less Cpig.
Rod O.D. 114.3 mm
PXWL Cplg. 117.5 mm

X-HEAVY DRIVE PIPE

SIZE	WT. Kg/m	CPLG. O.D.
65 mm	11.9	85.7
100 mm	23.4	131.8

DRILL RODS

	SIZE	WT. Kg/m	O.D. mm	CPLG. I.D.	
	EW	4.6	34.9	11.1	
X	AW	6.2	44.5	15.9	X
X	BW	6.4	54.0	19.1	X
X	NW	8.2	66.7	34.9	X
	HW	12.6	88.9	60.3	
	A	5.6	41.3	14.3	
	N	7.3	60.3	25.4	

FLUSH COUPLED CASING

SIZE	WT. Kg/m	O.D. mm	I.D. mm
EX	2.7	46.0	38.1
AX	4.5	57.2	48.4
BX	6.7	73.0	60.3
NX	8.9	88.9	76.2

X = MOST COMMONLY USED EQUIPMENT BY NYSDOT DRILL CREWS

IMPREGNATED BIT SELECTION CHART

DCDMA CODES	ROCK CHARACTERISTICS	TYPES OF ROCK	ACKER	CRAELIUS	DIAMOND DRILL	HOFFMAN	HUDDY	LONGYEAR	CHRISTENSEN	SPRAGUE & HENWOOD
1	EXTREMELY HARD, UNBROKEN FINE GRAINED FORMATION NON-ABRASIVE	QUARTZ CHERT JASPER	YELLOW	KS	BLU STD 54E	BRONZE	H-10 H- 8 H- 6	SERIES 10	BLACK #2	BLUE
2	VERY HARD, UNBROKEN FINE GRAINED FORMATIONS NON-ABRASIVE	QUARTZITES TACONITES DIORITES	GOLD	KS	BLU STD 54B		GOLD	SERIES 9	BLACK #1 BLACK #2	TAN BROWN
3	HARD, FINE TO MEDIUM GRAINED, UNBROKEN FORMATION	GRANITE ANDESITES GNEISS SCHIST BASALT	SILVER	KM	BLU FCHM	RED	YELLOW ORANGE	SERIES 8 (COPPER)	BLACK #1 TAN	TAN ALT. SILVER BROWN
4	MODERATELY ABRASIVE MEDIUM TO COARSE GRAINED FORMATIONS SOLID TO SLIGHTLY FRACTURED	PEGMATITES GABBRO MONZANITES	ORANGE	KM	BLU STD 54	GREY	RED	SERIES 6	TAN	SILVER BROWN
5	ABRASIVE, MEDIUM TO COARSE GRAINED FORMATION, BROKEN	QUARTZITES CONGLOMERATES SANDSTONE RHYOLITES	GREEN	HM	BLU FCHM	BLUE	GREEN SILVER- BLUE	SERIES 4 (SILVER)	TAN GREY	GREEN ALT. YELLOW RED
6	ABRASIVE, MEDIUM TO COARSE GRAINED, FRACTURED, BROKEN	SANDSTONES PEGMATITES TACONITES QUARTZITES	GREEN	HM	BLU FCCI		BLUE	SERIES 2 (GREEN)	GREY	GREEN ALT. YELLOW RED
7	EXTREMELY ABRASIVE MEDIUM TO COARSE GRAINED HIGHLY FRACTURED, FAULTED & SHEARED GROUND	SANDSTONES QUARTZITES GRANITES	BLUE	HH	BLU T4B	GREEN	BLACK	SERIES 1	GREY	RED

INFORMATION SHOWN ON THE CHART WAS SUPPLIED TO THE DIAMOND PRODUCTS COMMITTEE BY MEMBER COMPANIES OF DCDMA. THE BIT SELECTION AS SHOWN BY EACH MANUFACTURER IS A GENERAL GUIDE THAT HE FEELS WILL GIVE OPTIMUM PERFORMANCE IN THE DESIGNATED FORMATION. HOWEVER, DUE TO THE VARIATIONS IN ROCK CHARACTERISTICS, RECOMMENDED BITS SHOULD NOT BE LIMITED TO THESE FORMATIONS SINCE THEY MAY PERFORM WELL IN OTHER APPLICATIONS.

SM 92a (9/82)

BUREAU OF SOIL MECHANICS

DIAMOND BIT REPORT & SERVICE RECORD

DIAMOND BIT SERIAL NO	
OUT OF SERVICE DATE	BIT SIZE
DISTRICT NO	SHT OF

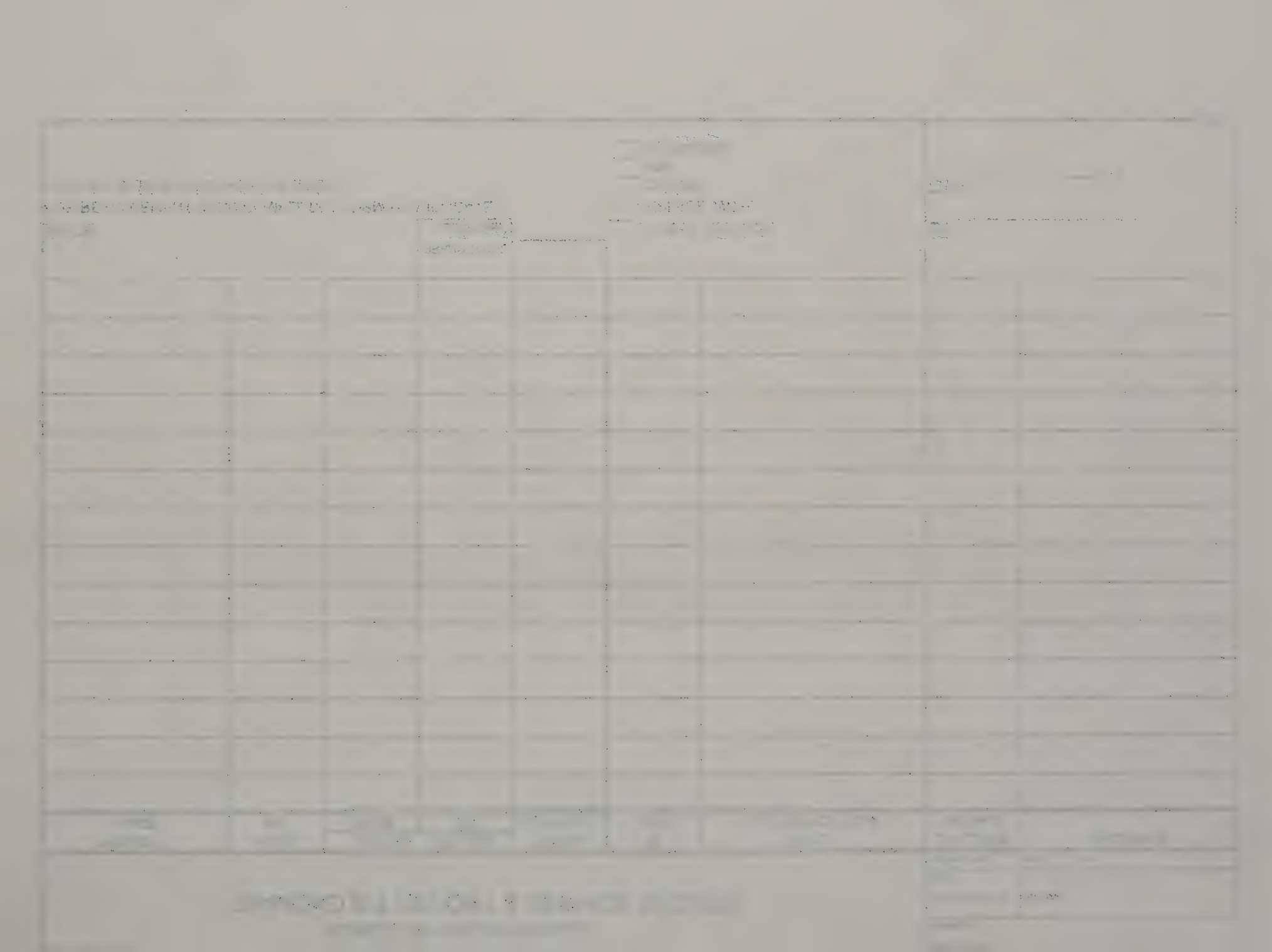
PROJECT NAME	HOLE NO	DEPTH DRILLED FROM	TO	TOTAL DEPTH (m)	% REC	ROCK CLASSIFICATION	DRILLER'S INITIALS	REMARKS
			GRAND TOTAL DEPTH (m)					

NOTE:
FOR REPLACEMENT SEND COMPLETED FORM IN DUPLICATE WITH BIT TO SOIL MECHANICS BUREAU

___ DO NOT REPLACE
REPLACE WITH:
___ COARSE
___ FINE
___ EXTRA FINE

BY:_____ _____

TITLE:____ _____



USE OF CORE BARRELS

Proper use of core barrel types and size is all important to the quality of information used in design. Using the wrong core barrel can result in poor information leading to a design that falls short in efficiency and economy. Core barrel types should be chosen according to the following standards:

Single Tube:

1. Used in overburden drilling such as boulders and obstructions.

2. Used to advance hole for drilled in casing when boulders are encountered.

3. Used in any drilling to advance hole when core recovery is of no concern.

Double Tube Swivel Type

1. Minimum type barrel to be used if recoveries are of concern.

2. Used to core ledge of any description as long as recoveries are adequate or above 85%.

Double Tube Swivel Type "M" Series

1. To be used in soft ledge rock when the double tube will not retrieve adequate core due to water erosion and poor core support.

2. This barrel should never be used to drill boulders.

Double tube (Solid or Split) Swivel Type Christensen Design

1. To be used for in situ (natural place) core recovery.

2. To be used when core is to be kept intact for a period of time and stored in plastic.

3. To be used for maximum recovery in soft friable conditions.

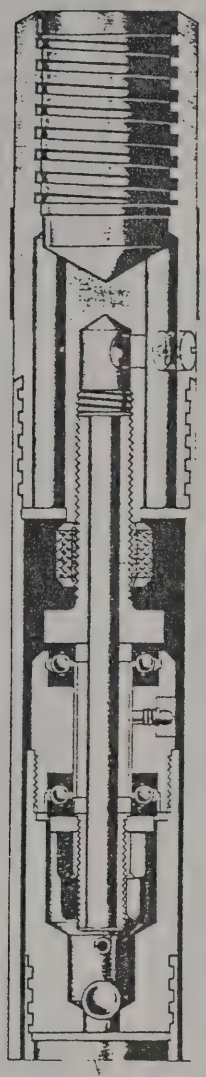
Double Tube Swivel Type Longyear Wireline (NQ-50 mm)

1. To be used when coring more than 6 m of rock in bedrock (saves time because no drill rod is used)

Note:

Increased core recovery is gained by increasing core diameter more than by changing core barrel types. In any case, nothing less than a double tube swivel type core barrel shall be used to drill ledge rock for identification and recovery.

S & H SERIES "SC" HEAVY DUTY ROCK CORE BARRELS



Core Barrel Parts
Are Listed on Page 14

Sprague & Henwood, Inc. are pleased to announce the development of a new heavy duty swivel type core barrel. Extensive field testing has shown that this barrel offers many distict advantages over the standard types of barrels currently on the market. Two sizes are available and are designated "NW-SC" and "BW-SC". Both sizes are available in 5 ft., 10 ft. and 15 ft. lengths.

DESIGN FEATURES

1. The barrels are compatible with D.C.D.M.A "nesting principle" of core barrels and casing sizes. The set bit O.D. is identical to standard bit dimensions.
2. A threaded adjustment is provided in the inner tube head assembly to accurately control the clearance between the end of the lifter case and the throat of the bit.
3. The inner tube is stabilized or centered by means of a replaceable inner tube guide ring.
4. A ball check valve in the inner tube head assembly allows fluid in the inner barrel to be displaced to the low pressure area outside of the core barrel. The ball closes to prevent pressure on the top of the core when the barrel is being withdrawn. Fluid passages are of ample size with a minimum of restrictions.
5. Two radial thrust bearings support the inner tube and permit it to remain stationary during drilling operations. Provision is made for easy lubrication of both bearings.
6. Hard facing strips are standard on the outer tube head to provide greater wear resistance.
7. The core lifter is contained in a lifter case which is in turn mounted on the inner tube. This is the design which has been proven so successful in coring soft or friable strata.
8. The outer tube is fabricated from heavy wall tube to increase its working life. The heavier wall tube is also less susceptible to damage under heavy drilling pressure.
9. Core can be removed from either end of the inner tube.
10. The barrels are suitable for use with either clear water or drilling mud as the circulating fluid.
11. Bits can be furnished as "bottom discharge" or "internal discharge" types.
12. Large diameter straight holes in the head and a large annular space between the inner and outer barrel provide for an increased and unrestricted flow of the circulating fluid.

SPECIFICATIONS

SIZE OF COREBARREL:	"NW-SC"		"BW-SC"	
	INCHES	MM	INCHES	MM
O.D. of Outer Tube	2-29/32"	74	2-1/4"	57
I.D. of Outer Tube	2-5/8"	67	1-11/16"	43
O.D. of Inner Tube	2-3/8"	60	1-3/4"	44
I.D. of Inner Tube	2-3/32"	53	1-1/2"	38
Hole Diameter	3"	76	2-3/8"	60
Core Diameter	2-1/16"	52	1-7/16"	37
Drill Rod Connect.	NW		BW	

CORE BARREL ASSEMBLY

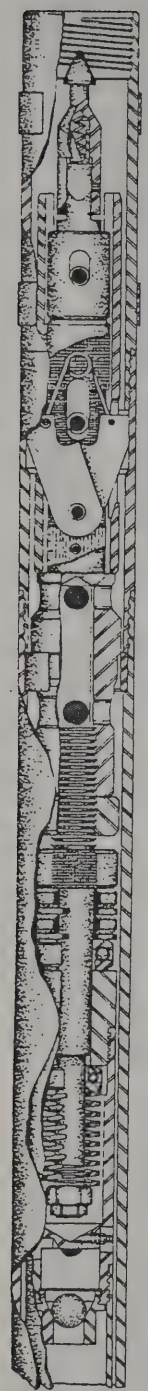
SIZE	"NW-SC"			"BW-SC"		
LENGTH	Assembly No.	Wt. Lbs.	Wt. Kg.	Assembly No.	Wt. Lbs.	Wt. Kg.
5 Ft. 1.5 M	A014000-5	70	32	A014053-5	55	25
10 Ft. 3 M	A014000-10	116	53	A014053-10	88	40
15 Ft. 4.5 M	A014000-15	161	73	A014053-15	116	53

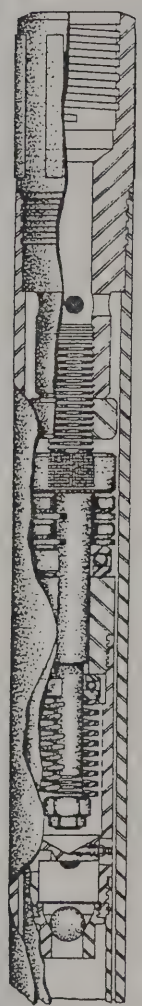
CORE BARREL ASSEMBLIES WITH SPLIT INNER TUBES

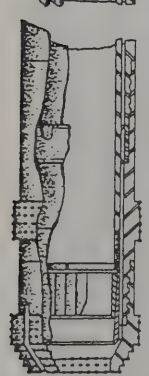
5 Ft. 1.5 M	A014419-5	66	30	—		
10 Ft. 3 M	A014419-10	152	69	—		

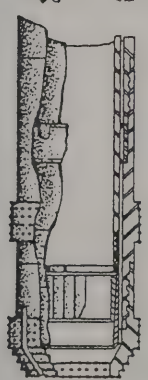
Longyear®
CORING SYSTEMS

2 inch = 51 mm









NQ-2″ WIRELINE "KNUCKLE HEAD"

NV-2″ DOUBLE-TUBE SWIVEL TYPE

Longyear's 2 Inch Coring Systems are available in 2 different configurations – wireline or "conventional" – and lengths of 5, 10 or 15 feet to meet your need for maximum core recovery.

NV-2″: This non-wireline double-tube swivel type core barrel provides high quality core recovery with minimum investment (up to 27% LESS than some competitive core barrels).

NQ-2″: All the advantages of wireline core drilling plus the desired 2″ diameter core makes this a very desirable and cost efficient coring system.

FLEXIBILITY: Because components are interchangeable (19 out of 20 parts used in NV-2″ core barrel are also used in the NQ-2″ core barrel), the coring systems may be easily converted as required from NV-2″ to NQ-2″ to NQ to NQ-3 to NV to NV-3.

To obtain more core at lower costs contact your Longyear representative today.

Description		NQ-2″	NV-2″
Core Barrel –	5 ft. (1.5 m)	45528	44377
	10 ft. (3.0 m)	43609	43608
	15 ft. (4.5 m)	45529	44632
Head Assembly		43611	43632
Inner Tube Assembly –	5 ft. (1.5 m)	45530	
	10 ft. (3.0 m)	43610	
	15 ft. (4.5 m)	45531	
Compact Overshot		44443	

CAUTION: "Knuckle Head" core barrel assemblies require a compatible overshot. The previous design overshot will *NOT* work with this system.

COMPACT OVERSHOT

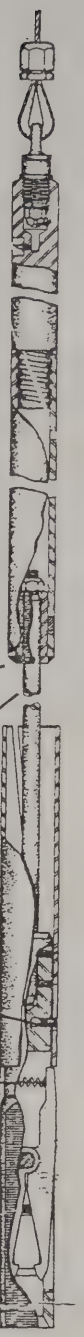
The "compact" overshot, which has an extended overshot head, was expressly designed to be compatible with the "Knuckle Head" core barrels. It has the following features:

Compact Design — For easier out-of hole handling, the over all length has been shortened 18 inches (457 mm) in all sizes, except PQ which has been shortened 32 inches (813 mm). However, this does not affect the jarring action as there is no significant reduction in weight.

Simplified Design — The shear pin and unnecessary threaded connections have been eliminated, resulting in an even simpler, more trouble-free design.

Jar Tube Weep Hole Relocation — Relocating the lower weep hole from the side of the jar tube to the bottom eliminates spraying water as the overshot is pulled out of the drill hole.

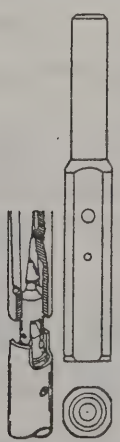
Stronger Jar Staff — The jar staff diameter has been increased in all sizes.



Improved Locking Sleeve Retainer

Stronger Compression Spring — Increased strength means greater gripping force for the lifting dogs.

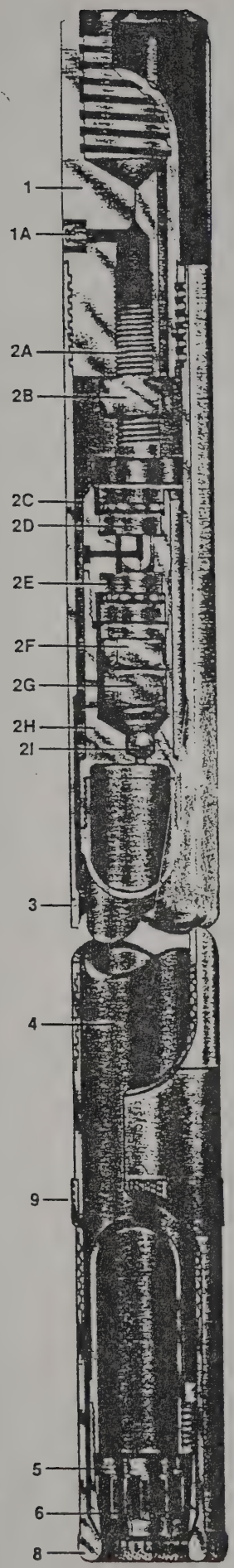
Extended Overshot Head — The extension and full circle design ensure proper engagement of the spearhead and the overshot.



When the extended overshot is attached to the "Knuckle Head" assembly, the extension fully encircles the spearhead and maintains constant and proper alignment. This design ensures that the lifting dogs maintain their grip on the spearhead, particularly when handling the inner tube assembly out of the hole.

Full circle alignment prevents the inner tube assembly from accidentally disengaging from the overshot. It also overcomes the problem of distortion of the overshot. These safety factors prompted Longyear to "knuckle" the inner tube rather than the overshot.

CAUTION: The compact overshot cannot be used with the previous design non-knuckle spearhead core barrels.



NWD4 Series D4 Core Barrel

Hole Size	Core Size	Outer Tube O.D.	Outer Tube I.D.	Inner Tube O.D.	Inner Tube I.D.	Rod Connection
75.70 mm	51.30 mm	73.81 mm	65.07 mm	60.33 mm	54.23 mm	NW

Part Description	Part Number	Weight (kg)
Core Barrel Assembly (1524 mm)	25-191-016S	26.27
1. Core Barrel Head, NW Rod	25-192-030S	3.64
A. Grease Fitting	6-041-016S	-
2. Bearing Assembly	25-271-032S	2.39
A. Bearing Shaft	25-089-053S	0.62
B. Nut, Lock	6-015-218S	0.14
C. Bearing Retainer	25-092-057S	0.14
D. Bearing, Thrust Ball	25-093-071S	0.17
E. Bearing, Thrust Ball	25-093-071S	0.17
F. Nut, Hex, Flanged	6-042-162S	0.14
G. Nut, Hex, Regular	6-015-200S	p01
H. Inner Tube Connector	25-274-036S	0.97
I. Ball, Stainless Steel, 12.7 mm Dia.	6-043-020S	-
3. Outer Tube, 1524 mm, C.P. Ends	25-272-014S	12.61
4. Inner Tube, 1524 mm, C.P. ID	25-273-012S	6.48
5. Inner Tube Shoe, BW, C.P. ID	25-097-171S	0.26
6. Core Lifter, Skirtless	25-095-076S	0.03
7. Thread Protector Sub	25-105-115S	0.88

OPTIONAL EQUIPMENT

8. Bit (See SD-512 B Price List)		
9. Reaming Shell Sub	25-197-112S	0.45
A. Reaming Shell (See SD-512 B Price List)		
10. Inner Tube Shoe, Basket Type	25-099-128S	0.26
11. Inner Tube Shoe, Pilot, BW, C.P.	25-100-165S	0.26
12. Blow Out Plug	25-285-032S	4.32
13. Pump Out Plunger	25-071-028S	1.14
14. Tube Clamp, Outer	25-106-014S	2.50
15. Core Lifter, Skirtless, HF	25-094-053S	0.03
16. Adapter Sub, N Box to NW Pin (15-613)	25-069-048S	2.61
17. Split Tube Conversion		
Inner Tube, Split, 1524 mm	25-281-015S	6.48
Inner Tube, Split, 3048 mm	25-281-023S	13.18
Inner Tube, Split, 4572 mm	25-281-031S	19.65

For other core barrel lengths all parts are interchangeable except those described below.

CORE BARREL ASSEMBLY (3048 mm)	25-191-024S	44.73
3. Outer Tube, 3048 mm, C.P. Ends	25-272-022S	24.37
4. Inner Tube, 3048 mm, C.P. ID	25-273-020S	13.18

CORE BARREL ASSEMBLY (4572 mm)	25-191-032S	63.81
3. Outer Tube,4572 mm, C.P. Ends	25-272-030S	36.98
4. Inner Tube, 4572 mm, C.P. ID	25-273-038S	19.65

CORE BARREL ASSEMBLY (6096 mm)	25-191-040S	83.98
3. Outer Tube, 6096 mm, C.P. Ends	25-272-048S	50.44
4. Inner Tube, 6096 mm, C.P. ID	25-273-046S	26.36

UD HOLE WITH HYDRAULIC SAMPLER

The drill rig set up is of prime importance for an undisturbed hole. Good "housekeeping" around the rig is of great importance. It is imperative that the operation be smooth and systematic. The following is a general guideline for the setting up and the operation of hydraulic sampling:

1. In order to gain height at the drill unit, the rig should be set with the radiator end toward the uphill side of the hole if the ground is uneven.

2. As soon as the mast is up, the cable should be stripped from the drum and relocated over the sheave. This is the most convenient location for the work to be done.

3. The next most important step is to set up a solid level platform or work deck. This platform should be a minimum of 2 m by 2 m and decked with 50 mm stock.

4. The sample processing area should be set up in a convenient location, preferably near a vise, if one is mounted on the rig. This area should be to the side or to the motor end of the rig so as not to interfere with the sampling down hole operations. This area should include a work table, a source of heat for melting wax and carriers for always keeping the tubes upright.

5. If at all possible, the drill truck should be parked in the immediate area of the rig so that supplies are convenient.

6. Availability of water is of prime importance. Fresh water pumped from a local source is ideal. Recirculating water is the next best system, if more than 20 percent of the work day is spent hauling water.

Tools

The following is a minimum list of tools that must be on hand during the progression of an undisturbed hole. Keep in mind that substitute tools are not advisable or acceptable and the lack of any one tool can shut down the operation and waste time.

Drill trucks are capable of carrying all the tools and no drilling unit is complete or efficient without all of them.

NOTE: *indicates a sufficient quantity to complete the boring.

1. * 100 mm pipe or "HW" casing.
2. * 100 mm or "HW" drive shoes.
3. 2-100 mm or "HW" drive heads.
4. * NW drill rods.
5. At least two 0.6 m and two 1.5 m "NW" drill rods.
6. Drive head for "NW" drill rods.
7. 1 open and 1 closed "NW" rod ring.
8. 2 open and 1 closed "NW" rod lifter.
9. 1 plain type water swivel with "AW" rod box to "NW" rod pin sub.
10. 1-88.9 mm chopping bit.
11. 1 92 mm jet auger.
12. 1-95.2 mm roller bit.
13. 1-88.9 mm quarry bit.
14. 1-88.9 mm Proctor-Moran type sampler capable of accepting a brass liner.
15. Flap and/or basket retainer for 88.9 mm sampler.
16. * Brass liners and caps.
17. 1 hydraulic sampler.
18. At least one extra set of leathers.
19. * Shelby tubes and caps.
20. * Tape and labels.
21. * Wax supplied by Soil Mechanics Bureau.
22. * Sawdust or newspaper for packing samples.
23. Torch or heat supply for melting wax.
24. Pot for melting wax.
25. Dipper for hot wax.
26. Cut off cooking spoon for trimming samples.
27. Holders for Shelby tubes.
28. 2-1 m chain wrenches.
29. 2-1 m pipe wrenches.
30. 2-600 mm pipe wrenches.

31. 2-350 mm pipe wrenches.
32. 2-200 m pipe wrenches.
33. 1 large screw driver-250 mm.
34. Ruler and Keel.
35. * oil and grease.
36. 1-300 mm chain wrench.
37. "NW" hoisting plug.
38. Core barrels (if coring is required)

    1 - 1.5 m single tube
    1 - 1.5 mm double tube
    1 - 5 "NXM" double tube

39. * Diamond bits.
40. * Pyramid bits.
41. Subs "AW" to "NW".

Procedure

We will consider at this point that the rig, platform, and processing area are set up and the hole is ready to be started. We also will assume we have a three man crew; 1 operator, 1 assistant and 1 laborer. The samples will be taken at 1.5 m intervals.

1. A surface sample is pressed. A Shelby tube is affixed to a Shelby head, which is screwed into the rod in the spindle. The tube is lowered to the ground surface, marked 450 mm and pressed with the hydraulic system 450 mm. A waiting period of 5 to 15 minutes is required for the pressed material to rebound; five minutes for firmer material and 15 minutes for softer soil. The tube is turned by the rig slowly for 2 to 10 revolutions. Then the tube is withdrawn, using the hydraulic while turning the tube. Remove the tube from the Shelby head and process as described later.

2. Assuming we are using 100 mm pipe, we will continue. A 1.5 m length of pipe with a drive shoe on the bottom end, is marked in 300 mm increments. A 100

mm drive head is lifted with the rig and screwed on the threaded end of the pipe. 100 mm pipe should be used with threads up and a coupling on the drive head. The pipe is then driven into the ground using a 450 mm drop and a 136.3 kg hammer. The blows per 300 mm are counted and entered into the log. When the fifth mark is at ground level, the drive head is removed.

3. Next, a choice of cleanout tools must be made. In general, the following table can be used:

Casting Blows/300 mm	Tool
1-10	jet auger
10-25	chopping bit
over 25	drag bit or roller bit

Note: No matter what tool is used, the last 50 mm must be cleaned out with a jet auger. The selected tool is fitted to the proper amount of drill rods and a water swivel screwed to the rods. Water is pumped into the hole. From this point on, until the sample is removed from the hole, the pipe must remain <u>full</u> of water. The hole is cleaned to 50 mm of hole bottom. If clear water is used, the hole should be surged until the water returns clear. When surging to clear water, it is not necessary to touch the bottom of the hole. The jet auger is used to clean out the last 50 mm. The jet auger is then rotated with a <u>wrench by hand</u> to the sampling level. No water is used in this operation. If the jet auger is working properly, the face of the jet auger will be smeared and plugged with a cohesive soil. If sand and/or gravel is in the soil to be sampled, a jet auger with a calyx (a sludge barrel) should be used with water to 60 mm of the bottom. Occasionally, gravel of a larger diameter will not wash out. If this happens, the following procedure should be attempted. Clean out the hole using the selected tool to the 1 m level. Using a Shelby head with a tube attached, press or drive if necessary, to a 1350 mm level. Remove tube and empty. Re-enter the tube and press to the 1.5 m level using the hydraulic if necessary. Rotate the tube to shear the sample. Remove and empty tube again. If a Shelby head fails to recover the clean out, the hydraulic piston may be used. As a last resort, a 88.9 mm sampler with a trap may be used. Keep in mind that throughout all this, the pipe must remain full of water. After two clean outs, the gravel should

have been eliminated from the hole.

4. With the hole clean and full of water, the actual sampling of the soil is next.

Note A: First, at the surface, pump water through the hydraulic sampler to see if it fully extends and water sprays out relief holes. This is especially important in the winter time when the sampler could freeze.

Note B: After each sample, the piston of the hydraulic sampler is cleaned and oiled, including the vent hole in center of piston. The inside of the tube should be lightly oiled. It is a good idea to put a covering of grease on bottom of piston.

Note C: For lifting the sampler into the hole, it helps to put a 600 mm "NW" rod on top of the sampler and use a close "NW" ring.

Note D: Next, lift sampler to vertical position. Place cutting edge of tube on wooden block. Compress sampler to cocked position (making sure the piston is at bottom of the tube) and insert gently to approximately 150 mm above sampling depth. Hold rods at this depth using two open rod lifters or pipe vise.

5. Next the rig is rammed forward until the drill rods are aligned. Fill rods with water and connect drill rods. Recheck measurements for proper depth. Tighten chuck and hook up water host to pressure pump. Lower rods hydraulically to sampling depth. Watch the pressure gauge. Apply pressure to system. Tube has blown fully when water flows over casing in a rush. If no water flows, increase pressure of pump and try again. If pump pressure reaches 1700 kPa, discontinue sampling attempt. Beyond 1700 kPa a stationary piston sampler should be used and pressed mechanically.

6. There is now a waiting period of between five and 15 minutes. The softer the material the longer the wait. After the waiting period, rotate in first gear slowly 5 or more revolutions. Then, continue to rotate as you raise the rods hydraulically. Be sure casing is full of water at all times, for this helps to

keep the sample in the tube.

7. The rods are now withdrawn and broken as gently as possible, making sure to keep the water level at top of pipe. When the sample clears the pipe, a plastic cap is fitted over the end immediately.

Note A: If no sample is recovered, a driven sample is taken, using a brass liner. This liner is waxed, taped, and labeled, but it is not necessary to keep it vertical.

Processing

Processing must be done on the site as soon as possible.

1. The Shelby tube is washed and the piston is unscrewed enough to allow air to vent in. The tube is then pulled free from the piston.

2. The amount of recovery is measured and entered into the log. If there is an excessive amount of "wash" on top of the sample, it should be removed with a flattened cook spoon. After the sample is trimmed neat and flat, a rag is used to wipe the inside of the tube above the sample. Check to ensure that the soil adheres to the walls of the tube so that wax will not run between the tube and the sample.

3. The next step is to pour hot (not boiling) wax with a measured ladle so that a 10 mm plug of wax is formed. Be sure that the wax adheres to the wall of the tube to produce a moisture proof seal. After the wax cools, the remaining space is filled with sawdust or paper to the point of being firm. A plastic cup is fitted over the end and sealed with several turns of black friction tape.

4. The tube is turned upside down and the plastic cap removed. This time the soil is trimmed flat and smooth so that a 20 mm wax plug can be formed. Again make sure the soil and wax adhere to tube respectively. This plug must be at least 20 mm because it acts as a ram when the soil is jacked out of the tube. Cap and tape.

5. Now wipe the outside of the tube and place a label on the lower half so that the top edge of label is pointing toward top of tube and tape to tube. If the label is on the top half, it is destroyed in the jacking procedure. Secure the label with friction tape. Fill out label completely to include amount pressed, amount recovered and any remarks that were put in the drill log.

6. The tubes are kept in an upright position until delivery at the Soil Mechanics Bureau. They should never be frozen or exposed to excessive heat. The sooner they are delivered, the less chance of damage.

GENERAL PURPOSE:

Thin wall tube samples are taken to obtain undisturbed samples for laboratory testing, to determine the strength and settlement properties of fine grain material. It is extremely important that the samples be pressed and transported with a minimum amount of disturbance. Poor sampling and careless handling of samples causes misleading test results that could lead to uneconomical designs.

1. MEASUREMENTS

A. This includes measurement of casing or drive pipe, drilling tools, sampler length, and recovery of sample pressed.

2. CLEANING OUT THE HOLE

A. The hole should be cleaned out thoroughly before sampling.

B. Clean out should be done with a clean-out jet type auger for the last 50 mm. If the material cannot be removed with these tools, the use of conventional type tools will be permitted. A thin wall tube and Shelby head may be used to clear the hole.

C. Do not use bottom discharge bits in soft soils. Frequently, samples are received with jet holes in the center.

3. RATE OF PRESS

A. Thin wall tubes should be pressed by a smooth, continuous operation.

B. A continuous fast press taking less than 5 seconds may be used.

C. For soft soils, wait 5 to 15 minutes before rotating the sampler to shear the end of the sample. For firm soils, a waiting period may not be required.

4. AMOUNT OF SAMPLE PRESSED

A. Overpressing causes sample disturbance. Do not overpress.

B. For stationary piston type samplers, the maximum press should be 450 mm. Before lowering the sampler to the bottom of the hole, a positive locking device to hold the actuating rod stationary should always be used and rewashed before pressing the sample. After removing the sample from the drill hole, be sure to back off the actuating rod to break the vacuum before removing the piston from the sampler.

C. There may be conditions where full recovery may not be obtained. If recovery is greater than 150 mm, retain the sample in the tube. If recovery is less than 150 mm, remove the sample from the tube, and cut the sample to fit in the jar. Do not mash or remold the sample. Forward the jar to the Soil Mechanics Bureau with the tube samples.

D. If the sample cannot be pressed, use a 88.9 mm split barrel sampler with a liner.

5. WAX PLUGS

A. A wax plug approximately 20 mm in thickness should be poured in the bottom of the tube (cutting edge end). The laboratory uses this plug as a piston in pushing the sample out.

B. A wax seal not greater than 10 mm in thickness should be poured in the top. Please avoid thick plugs as they are difficult to remove.

C. Premixed wax will be furnished by the Soil Mechanics Bureau.

6. SEALING TUBE

A. Any space remaining between the wax plug and the top of the tube should be filled with light, loose material such as sawdust.

B. Plastic caps should be placed on each end of the tube and secured to the tube with friction tape. No waxing is required on plastic caps.

7. LABELING TUBES

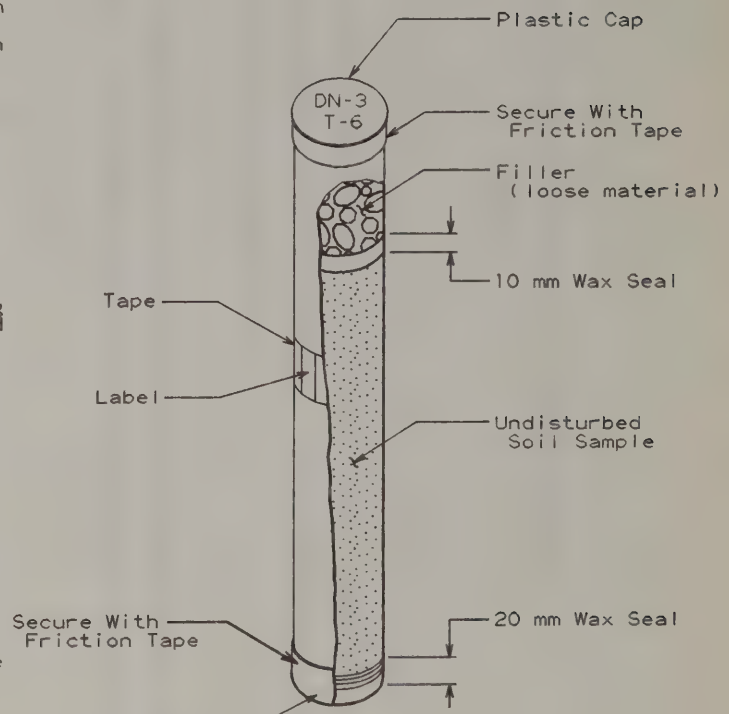
A. Print the hole number and sample number on the top cap with magic marker. This is a precaution against the label being lost.

B. Paste and tape the label on the tube approximately 300 mm from the top of the tube with friction tape or masking tape. The label should include P.I.N., sample number, project name, hole number, station, offset, depth of sample, depth pressed, recovery, and any remarks by the driller, use label SM 251d (11/78).

8. TRANSPORTING SHELBY TUBES

A. Careful sampling in the field can be ruined by careless handling of samples. Transport and ship the samples in an upright position. Carrying racks with proper cushioning should be used. The design for the rack is available from the Soil Mechanics Bureau. Handle tubes carefully and avoid dropping, rolling, and banging them together.

B. Protect the sample from freezing or excessive heat.



SHELBY TUBE
Not To Scale

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION SOIL MECHANICS BUREAU	DRAWING NO. SM 1627 R4	R1-5/65, R2-12/77, R3-10/80, R4-8/94
	PREPARED BY: T.B.F. CHECKED BY: M.E.L.	
		INSTRUCTIONS FOR UNDISTURBED SAMPLING OPERATIONS

DN HOLE WITH UD SAMPLES AT 1.5 m INTERVALS

SETUP

The setup of the drill rig is of prime importance to an undisturbed hole. Good "housekeeping" around the rig during operations is also of great importance. It is imperative that the operation be smooth and systematic. The following is a general guideline to setting up the drill rig and operation.

1. In order to gain height at the drill unit, the rig should be set with the radiator end toward the uphill side of the hole should the ground be uneven.

2. As soon as the mast is up the cable should be stripped from the drum and relocated over the sheave in hoisting position. This is the most convenient location for the work to be done.

3. The next most important step is to set up the platform or work deck. This platform should be a minimum of 2 m by 2 m and decked with 50 mm stock. This platform shall be level and solid.

   A 3 m "NW" rod is placed in the spindle with a 3 m actuating rod extension inside and locking coupling at top of rod to hold actuating rod.

4. The sample process area should be set up in a convenient location, preferably near a vise if one is mounted on the rig. In all cases this area should be to the side or to the motor end of the rig so as not to interfere with sampling operations. This area should include a work table, a vise, a source of heat for melting wax and carriers or stands for keeping samples upright while working on them.

5. If at all possible the drill truck should be parked in the immediate area of the rig so that supplies are convenient.

6. The pump condition and water availability are also of prime importance. Fresh water pumped from a local source is ideal. Recirculation of water

is the next best system and the last choice would be to haul water. The choice to recirculate or haul water has to be weighed in each individual case. As a thumbnail rule, if 3 or more hours of an 8 hour day is spent hauling water, a recirculating system should be considered.

TOOLS

The following is a minimum list of tools that must be at hand during the progression of an undisturbed hole. Keep in mind that substitute tools are not advisable or acceptable and lack of any one tool can shut down the operation and waste time. Drill trucks are capable of carrying all the tools called for and no drilling unit is complete or efficient without all of them.

NOTE: * indicates a sufficient quantity to complete the boring.

1. * 100 mm pipe or "HW" casing
2. * 100 mm pipe or "HW" drive shoe
3. 2 - 100 mm pipe or "HW" drive heads (complete)
4. * "NW" drill rod
5. * actuating rod
6. at least 2 600 mm sections and 2-1.5 m sections of "NW" drill rod and an equal amount of short actuating rod section
7. drive head for "NW" drill rods
8. 1 open and one closed "NW" rod ring
9. 2 open and one closed "NW" rod lifter
10. 1 plain type water swivel with "AW" rod box to "NW" rod pin sub
11. 1 - 88.9 mm chopping bit
12. 1-92 mm jet auger
13. 1 - 82.6 mm roller bit
14. 1 - 82.6 mm quarry bit or Hawthorne
15. 1 - 82.6 mm PROCTOR MORRAN type sampler capable of accepting brass liner
16. Flap or basket retainer for 88.9 mm sampler
17. * Brass liners and caps for liners
18. 2 stationary piston samplers complete and in good working order

19. At least one extra; set of leathers - locking cone - spring
20. * Shelby tubes
21. * Plastic caps
22. * Tape
23. * Wax
24. At least one "NW" locking coupling
25. 2 - 14 mm cable clamps
26. * Newspaper or sawdust for packing samples
27. Torch or heat supply for melting wax
28. Pot for melting wax
29. Dipper for hot wax
30. Cut off cook spoon for trimming samples
31. 2 - 1 m chain wrenches
32. 2 - 1 m pipe wrenches
33. 2 - 600 mm pipe wrenches
34. 2 - 350 mm pipe wrenches
35. 2 - 200 mm pipe wrenches
36. 2 vise grip pliers
37. 1 large screwdriver - 250 mm
38. Set allen wrenches
39. Metric Ruler
40. Keel
41. * Oil
42. * Grease
43. 1 - 300 mm adjustable wrench
44. 1 - 300 mm chain wrench
45. "NW" hoisting plug
46. Core barrels (if coring is required)

    1 - 1.524 m single tube
    1 - 1.524 m double tube
    1 - 1.524 m NXM double tube
47. * Diamond bits
48. * Pyramid bits

PROCEDURE

We will consider at this point that the rig, platform. and processing area are set up and the hole is ready to be started. We will also assume we have a three man crew; an operator, assistant, and laborer. The samples will be taken at 1.5 m intervals.

1. A surface sample is pressed (shelby tube is suitable for surface sample only). A tube is affixed to the shelby head and screwed onto the rod in the spindle. The tube is lowered to the ground surface, marked 450 mm and pressed with the hydraulic system 450 mm. A waiting period of 5 to 15 minutes is allowed, depending on the stiffness of the soil. Five minutes for firm soil and 15 for soft. The tube is turned with the rig slowly for 2 to 10 revolutions. The tube is then withdrawn using the hydraulic system. The tube is then removed from the shelby head and processed in the same manner as in the following procedures for processing.

2. Assuming we are using 100 mm pipe we will continue. A 1.5 m length of pipe with a drive shoe set to the bottom end, is measured in 300 mm increments. a 100 mm drive head is lifted with the rig and screwed onto the threaded end of the pipe. 100 mm pipe should be used with threads up and a coupling set to the drive head. The casing is then driven into the ground using a 450 mm drop and a 136.3 kg hammer. The blows per 300 mm are counted and entered into the log. When the fifth mark is at ground level the drive head is removed.

3. At this point a choice of cleanout tools must be made. In general the following table can be used:

Casing blow count/300 mm	Tool
1 to 10	jet auger
10 to 25	chopping bit
over 25	drag bit (Hawthorne or quarry bit)
	roller bit

NOTE: No matter what tool is used, the last 50 mm must be cleaned out with a jet auger.

After the choice is made, the selected tool is fitted to the proper amount of drill rod and a water swivel is fixed to the rod. Water is injected into the hole. From this point on until the sample is removed from the hole the casing must remain full of water. The hole is cleaned to 1.45 m below the ground surface. If clear water is used, the hole should be surged until the water returns clear. When surging to clear water it is not necessary to touch the bottom of the hole. The jet auger is used to clean out the last 50 mm. This tool is inserted in the hole and rotated with a wrench by hand to the 1.5 m level. No water is used in this operation. If the jet auger is working properly the face of the jet auger will be smeared and plugged with the cohesive soil. If sand or light gravel (up to 6 mm dia.) is in the soil to be sampled a jet auger with a calyx or sludge barrel should be used with water to the 1.45 m level. Occasionally gravel of a diameter larger than can be washed out will be throughout the soil to be sampled. If this is encountered the following procedure should be attempted. Clean out hole using the selected tool to the 1 m level. Using a shelby head with a tube attached, press or drive if necessary to 1.4 m level. Remove tube and empty. Reenter tube and press to the 1.5 m level using the hydraulic system if necessary. Rotate tube to shear the sample. Remove and empty tube again. If a shelby head fails to recover the cleanout, a piston may be used. As the last resort a sampler with a trap may be used. Keep in mind that through all this the casing must remain full of water. After two cleanouts the gravel should have been eliminated from the hole. Using one method or the other the hole should be clean to 1.5 m at this point.

4. With the hole clean and full of water, the actual sampling of the soil is next.

A. The stationary piston sampler is cleaned and assembled preceding each sample. Each part is oiled as it goes together. All threads, the locking cone and leathers are oiled. The inside of the shelby tube is oiled.

1. The piston and main actuating rod is inserted into the shelby tube. Force must be applied to the piston to set it. If no force is necessary, remove the piston and insert a rubber band under one of the leathers. Be sure that the main actuating rod is seated in the piston so the hole in the face of the piston is sealed completely. If a problem is encountered in venting the sample because of the soil adhering to the face of the piston and plugging the vent hole, a light coating of grease may be applied to the face of the piston. This will allow the vacuum to be broken more easily without chancing the loss of the sample.

2. The head section is then placed over the actuating rod and down into the shelby tube. Four screws are inserted in the holes and screwed in until flush.

3. The locking cone and spring are placed in the head. Be sure the cone is seated completely.

4. The sub is then screwed to the head section. At this point the length of actuating rod above the sub is measured. It is usually about 150 mm but may vary with the length of the shelby tube. This measurement must remain on each successive rod until the sampler is at the sampling depth. An increase in this measurement will indicate upward movement of the piston. If the upward movement for any reason is greater than 50 mm, the piston must be reset.

B. NOTE: We will assume the sampler is 1 m long.

The sampler is connected to a 600 mm rod and actuating rod by first connecting the actuating rod. This rod must be made tight with 200 mm wrenches. A locking coupling is attached to secure the actuating rod in place while lowering it into the hole. Next the sampler is made up to the 600 mm "NW" rod. The same 150 mm of actuating rod should now protrude from the 600 mm section of "NW" rod.

C. The sampler and 600 mm section is lowered into the hole and held with open rod lifters (using two lifters will keep the rod centered for hooking up) at an elevation in the hole 150 mm or less above the bottom of the hole.

D. Next the rig is rammed forward till the rods are aligned. The locking coupling is released and the actuating rod is lowered by hand and screwed to the stub in the 600 mm rod section. (A 600 mm section of actuating rod may have to be added to the top so that the actuating rod is not lost beneath the looking coupling). The chuck is then lowered hydraulically till the "NW" rods come together, then the chuck is released and withdrawn fully. The "NW" rods are screwed together, the chuck is tightened and the locking coupling is tightened.

E. Using the hydraulic system the sampler is lowered to the sampling depth (in this case 1.5 m).

F. Now the cable that has been rigged over the sheave wheel is run behind the drill unit and is hooked around the 100 mm pipe. A 14 mm cable clamp is loosely fitted around the cable below the sheave and slipped over the protruding actuating rod. With the winch clutch and brake the cable is made rigid and fast, then the cable clamp is tightened securing the actuating rod to the rigid cable.

G. The locking coupling is now released and a keel mark is placed on the "NW" rod 450 mm above the top of the pipe.

5. Now the sample is ready to be pressed.

A. The bypass valve is screwed down tight so that full pressure can be applied.

B. The feed valve must be open completely.

C. The throttle should be somewhere above 1/2.

D. The actual press is now made using the directional feed valve. The press should be made in one continuous stroke and as fast as penetration will allow. Using this complete method, refusal is established when there is no penetration with maximum hydraulic pressure (about 4100 kPa). When the keel mark comes to the top of the pipe, and assuming the rig did not lift, the press is complete.

6. There is now a waiting period of between five and fifteen minutes. The softer the soil the more time should be allowed to pass.

7. The valves are all replaced to neutral and the rig is put into first gear. The sampler should be rotated 5 to 10 turns very slowly (10 RPM). This disturbs the soil around the outside of the shelby tube so that when the tube is withdrawn the suction will be eased. It should then be withdrawn with the hydraulic system. Water must be fed into the pipe during the withdrawal and also while the sample is removed from the hole. This has a tendency to "float" the sample and help it stay in the shelby tube.

8. The rods are now broken and withdrawn with the recovered sample. Keep in mind that the hole must remain full of water until the sample clears the top of the pipe. As the sample clears the pipe a plastic cap is fitted over the end immediately. This should hold the sample should it try to slip. With a marking pencil, the number of the tube should be marked on the side.

9. If the sample is not recovered, a driven sample is taken using a brass liner. This liner is waxed and treated the same as a shelby tube. The only difference is that the liner can be transported in any position as it is already disturbed.

10. While two men repeat the operation from Step 2 the third man takes the sample and begins to process it.

PROCESSING

Processing must be done on the site so that it be protected during transportation.

1. The adaptor is broken loose from the head section and removed.

2. The sample is turned upside down and the actuating rod is tapped gently to loosen the cone. The cone and spring are removed and placed in oil.

3. The sample is replaced upright and the four screws in the head are removed. Then the head itself is removed.

4. There now remains the shelby tube holding the sample, the piston and the actuating rod. If there is silt on top of the piston it should be cleaned out before any attempt is made to remove the piston. It should be flushed with water.

5. The actuating rod is then unscrewed 10 to 20 turns and then the piston can be removed. Unscrewing the actuating rod allows air to follow along the flattened threads of the actuating rod and in between the face of the piston and the top of the sample.

6. After the piston is removed, the amount of recovery is measured and entered into the log. If there is an excessive amount of wash on top of the sample it should be removed with the flattened cook spoon. After the sample is trimmed neat and flat, a rag is used to wipe the inside of the tube above the sample. Care should be taken to insure that the cohesive soil has adhered to the walls of the tube so that wax will not be allowed to run between the tube and the sample.

7. The next step is to pour hot (not boiling) wax into the tube with a measured dipper. The dipper should be marked to a point where it will have enough wax to make a 10 mm plug. It is important that this plug be not more or less than 10 mm so that a good seal is formed and so it does not cause restriction when the sample is jacked out of the tube. Be sure the wax seals to the side

of the tube. It then has to cool to the point of being firm.

8. Now the remaining open space in the tube is filled with sawdust or paper to the point of being firm. A plastic cap is fitted over the end of the tube and two turns of black friction tape is put on to hold the cap.

9. The tube is turned upside down again, the plastic cap is removed and the other end is processed. This bottom end if fairly simple. The soil is trimmed back 20 mm of an inch and made flat and smooth. The wall of the tube is again wiped clean with a rag and wax is poured until flushed with the cutting edge. This plug must be 20 mm and flat because it is used as a ram when the soil is jacked out of the tube. After the wax has hardened, a plastic cap is fitted to this end and taped as with the other end.

10. Now the outside of the tube is wiped clean and a jar label is placed on the tube in the center or below. If the label is above center it will interfere with the jacking procedure. Two 6 mm strips of tape are placed around the tube and label at the top and bottom of the label to hold it to the tube during transportation.

11. The tubes are always kept in an upright position. They should never be placed on their sides. This is most important during shipment of the tubes. The tubes should never be allowed to freeze or come in contact with excessive heat. It is important that the shelby samples be transported as gently as possible.

USAGE OF H-STEM AUGERS

Hollow stem augers are used to advance and case the bore hole at the same time. The H-stem auger consists of a pipe with male and female keyed couplings welded to opposite ends. On the outside of the length of pipe is welded a continuous helical flight. Inserted in the female coupler is the cutter head with 4 carbide teeth. The drive cap slides onto the male coupler of the auger. The cutter head, drive cap, and additional augers are held in place by bolts which should not be over or under tightened. This will take some practice.

As the augers are rotated into the soil, the flights constantly bring up the cuttings to the surface of the boring. Unlike using casing the hole does not need to be washed out after advancing the augers. This saves one step in the drilling procedure and cuts water usage to a minimum.

When sample depth is reached the drive cap is removed and the rods and sampler are lowered into the hole. At this point it is important to take a measurement of the sampler depth to make sure the sampler is not on the soil plug in the end of the auger. If the soil plug is not more than 150 mm, then tap the sampler through it to the correct depth, before starting the sample. If the soil plug is more than 150 mm it should be washed out to the correct depth by conventional methods.

When augering in wet sands, it is not uncommon for the sands to travel up inside the augers 0.6 m to 4.6 m. When this happens it is a must to wash out the augers. Never attempt sampling when there is a significant amount of running sand inside the augers, as this would only give incorrect blow counts and an unrepresentative sample for that depth. After washing out running sand from inside the auger, a constant head of water should be maintained when removing rods and drill tools from the hole. This head of water should help hold down the running sand.

In extreme cases, a mud slurry should be mixed and pumped down the hole to hold back the sand. The auger method should not be used in areas of heavy concentration of boulders and cobbles or in areas expected to exceed over 30 m in depth.

When rotating augers it is recommended not to start under high torque, because this puts undue strain and wear on the whole drill string, especially the auger shank key ways. Once reaching sample depth with the augers, let the augers rotate for a time to bring up the cuttings. This will reduce the torque to a minimum.

Also it should be noted that leaving the augers in the ground for extended periods of time (ex. long weekends) could cause certain soils to set up around them, creating extreme high torque when attempting to rotate them. This should be avoided whenever possible.

MAINTENANCE OF HOLLOW STEM AUGERS

A. The cutter head should be kept at full gage to prevent excessive wear on the lead auger. The flights should be built up by hard facing from the E.M. shop when they reach 6 mm of wear.

The teeth in the cutter head should be checked periodically for broken or worn carbide.

B. Trade lead augers every so often, so that the drill string becomes evenly worn.

C. Have the gage of the augers maintained before they are beyond repair. Augers also should be built up by hard facing from the E.M. shop when they reach 6 mm of wear. This measurement is taken from the width of the Helix.

D. Keep auger shanks oiled and key ways well dressed so that augers slide together with little effort.

E. The bolts should screw in most of the way by hand. Do not force bolts in, if they start hard, remove bolt and run tap through insert until bolt goes in easily. Keeping bolts free from grime also helps. Keeping bolts in a small container of oil will keep them lubed.

When a bolt will not go in and the threads are in good condition it could be the result of the augers not being completely coupled together.

F. When the thread portion of auger becomes stripped beyond repair, notification shall be given to the Main Office so a replacement part can be issued.

Safety Tips for H-Stem Augers

1. Do not clean soil from augers while they are rotating.

2. Do not remove cuttings from around boring with your feet. If the cuttings need removing use a shovel.

3. Do not wear loose or unbuttoned shirts or clothing that could get caught in the rotating augers.

4. Long hair should be tied back or put up under the hard hat when working near rotating augers.

5. Do not clean threaded inserts with fingers. Use a wire pipe brush.

6. Do not rotate augers unless the holding fork is removed and the helper is clear of the auger string.

7. When tightening auger bolts make sure the drill unit is in neutral and the clutch is disengaged.

SLOPE INDICATOR INSTALLATION

Setup

If water is a problem, recirculating should be considered, because a tank is needed to mix grout in any case. Recirculating also eliminates the need of shutting down a traffic lane with a truck and water tank. The rig should be fitted with a 3 m "NW" rod in the spindle. The rig cable should be reaved over the crown sheave in a hoisting position. It will be useful during the installation.

Equipment Needed

The following is a minimum list of tools and equipment needed to install a Slope Indicator. Any attempt to "do without" or substitute needed tools or equipment is not economical and is time consuming. Drill trucks have ample space to haul all equipment necessary to complete any installation.

NOTE: * indicates a sufficient quantity to complete the boring.

1. * "HW" casing
2. * "HW" Drive shoe
3. 2 "HW" Drive heads (complete)
4. * "NW" and "AW" Drill rod
5. 2 - 1.5 m sections of "NW" drill rod
6. 2 - 0.6 m sections of "NW" drill rod
7. 1 each "NW" open and closed rod ring
8. 1 each "NW" open and closed rod lifter
9. 1 plain type water swivel
10. 1 - 95.2 mm ROCK ROLLER BIT if 88.9 mm indicator casing is used and 1-142.9 mm roller bit
11. 1 - 88.9 mm Chopping bit
12. 1 - 1.524 m "NX" Double tube core barrel and bit
13. * Bentonite (QUICK GEL)
14. * Cement
15. 2 - 1.5 m lengths of 150 mm pipe

16. 1 - 150 mm drive head with coupling attached
17. 1 - 88.9 mm split barrel sampler with trap
18. 1 drive head for "NW" rods
19. * Slope Indicator Casing (90 mm or 73 mm) - with couplings for each
20. Check Valve Assembly
    A. Slope Indicator cap with 25 mm hole
    B. 2 - 25.4 mm close nipple
    C. 1 - 200 mm length of 25.4 mm pipe (with 12 - 9.5 mm holes)
    D. 1 - 25.4 mm pipe cap
    E. 1 - 25.4 mm pipe coupling
    F. 1 - 25.4 mm check valve
21. 1 - 150 mm protective cap (furnished by Bureau)
22. * 25.4 mm rigid plastic pipe in 3m lengths with coupling for each
23. 2 - female 25.4 mm slip fit to 25.4 mm pipe adaptors
24. 2 - snap on to 25.4 mm make pipe adaptor
25. 1 - can glue (PVC)
26. 1 - hand drill
27. 1 - alignment tool for slope indicator pipe used
28. 6 m of 5 mm manila rope
29. 1 - 20 L pail
30. 1 - 4 L pail
31. pop rivet gun and rivets (furnished by Bureau)
32. 2 - 75 mm round bristle brushes (furnished by Bureau)
33. 1 - Master #17 lock (furnished by Bureau)
34. Centrifugal pump 50 mm size

Procedure

After the rig is set up and all equipment needed is at the site, the hole is started. 200 mm casing is driven at least 1.5 m, but no more than 3 m except in special cases or when directed by the engineer. The 300 mm casing is cleaned to the bottom using the 142.9 mm bit.

Samples should be taken if requested by the engineer. If no samples are requested the hole can be advanced in a standard method without sampling.

Using the "HW" casing the hole should be advanced to ledge or in some cases till.

If ledge is encountered, an "NX" core should be run no less than 1.5 m. This core is used to verify that the bottom of the indicator will be anchored at this elevation when grouted. If 88.9 mm indicator casing is to be used a 95.2 mm roller bit must be used to ream out the hole so it will accept the casing and allow room for the grout to get by.

If till is used to anchor the casing, no core is taken but a driven sample should be tried using a 88.9 mm sampler. This will be used to verify the till layer. Then the hole is drilled no less than 1.5 m with the 95.2 mm roller bit and washed clean.

The "HW" is seated on ledge or till and a 1.5 m hole is open ahead of it. At this point the hole should be ready for the Slope Indicator casing to be installed.

The check valve assembly is fitted to a 3 m length of indicator casing using at least two pop rivets. Tape is wrapped around the casing where it meets the cap and also over the holes in the rivets to stop grout from entering the casing. The casing is then lowered into the hole. The next 3 m length is fitted with a coupling and four pop rivets inserted. A 6 mm line is attached to the alignment tool and the line is threaded thru this 3 m length from the coupling end. The alignment tool is entered into the grooves of the S.I. pipe and left to protrude half of its length. This protruding half is entered into the grooves of the lower piece of pipe and the lower pipe is stabbed into the coupling. Pop rivets are inserted and this joint is taped. The alignment tool can be pulled through the upper length of casing after it has been entered into the hole. The pop rivets must be placed between the grooves in the

S.I. casing. All joints are taped to stop entry of grout.

As the casing enters the water filled hole it will become buoyant. In order to counteract this buoyancy, water is poured into the slope indicator casing. As it sinks a piece of 6 mm line is used to hold it or a chain vice if one is available. When the bottom of the hole is encountered a measurement should be taken to be sure it is at the desired elevation. The Slope Indicator casing is cut off at least 300 mm above the 150 mm pipe and two of the slots must be oriented perpendicular to the slide. In any case it must be cut off well above the "HW" casing so that the grout will not run into the S.I. casing when grouting starts. At this point the S.I. pipe must be tied down to the 150 mm pipe because the grout will float it out.

The next step is to install the grout pipe. A 3 m length of 25.4 mm rigid plastic pipe is fitted (with glue) to a slip-fit pipe thread adaptor. Each successive 3 m length is fitted with a coupling and glued to the next. When the bottom of the S.I. casing is reached the adaptor is screwed onto the protruding 25.4 mm nipple. The top of the grout pipe is cut off at a convenient working height (about 1.5 m from the ground surface) and this end is also fitted with a slip-fit 25.4 mm pipe thread adapter. A snap on 25.4 mm male fitting is screwed into the adaptor and it is ready to grout.

If sludge of any kind was left in the bottom of the hole from the drilling procedures water can be injected at this point to wash the S.I. casing down to the desired elevation.

The grout is then mixed using mix and volume charts available. The grout is mixed and delivered with a 50 mm centrifugal pump. The most efficient way to mix the grout is to mix the cement and water first and then add the quantity of Bentonite. After the proper amount of grout is mixed it can be pumped down the grout pipe. As the grout fills the hole the water will be expelled. When the grout flows from the "HW" casing, the grout is shut off but left to circulate in the tank.

A quantity of clear water is pumped down the grout pipe. This quantity should be 4 L for every 6 m of grout pipe. This will expel most of the grout from the grout pipe so that it will not fall back into the S.I. pipe when the grout pipe is removed.

If no water surges back up the 25.4 mm grout pipe this is a good indication the check valve is holding. The grout pipe is then removed, cutting each 3 m length with a hacksaw about 10 mm below each coupling so the pipe can be reused again.

In order to ensure that all the grout is out the S.I. casing, a hose should be fitted with two 75 mm brushes for 88.9 mm installations and one 75 mm brush for 73 mm installations. This is done by taping the brushes to a hose that has no coupling on one end and entering it to the bottom of the S.I. casing. Water is pumped down and the hole is surged by hand until the water returns clear.

After all the grout pipe is out, and the S.I. casing has been washed out clean, a string of "AW" drill rod is lowered to the bottom. This will hold the S.I. casing from floating while the "HW" casing is being pulled. A plastic bag should be taped around the top of the S.I. casing to ensure that no grout falls into it. The alignment of the grooves should be checked again to be sure it did not move.

The next step is to bump back the "HW" casing, refilling with grout from the surface after each 1.5 m section is pulled. As soon as possible the "HW" casing should be pulled with the winch. From the time the grout is mixed to the point where all the "HW" casing is out of the ground should be one continuous operation. If any casing is left in overnight with grout in it, the grout will adhere to the S.I. casing and the two casings will be locked together.

After the grout has been let to partially set (about 15 hrs) the 150 mm hole protector is screwed onto the 150 mm pipe and the S.I. casing is cut off flush with the top of the open protector. A pop rivet is installed in the wall of the S.I. casing for a reference point for elevation.

The last thing to be done is to measure the inside length of the S.I. casing exactly. This measurement is recorded. The protective cap is then closed and locked with a master #17 lock supplied by the Bureau. The reason for using only this lock supplied by the Bureau is that they are all keyed alike and the engineering forces can open any installation to read it with one key.

GROUT VOLUMES FOR SLOPE INDICATOR INSTALLATION

	O.D. of Slope Indicator Casing	
	73 mm (2 7/8")	88.9 mm (3 1/2")
75 mm (3")	.37 (.03)	-
88.9 mm (3.5")	1.99 (.16)	-
100 mm (4")	3.85 (.31)	1.86 (.15)
114.3 mm (4.5")	6.08 (.49)	4.10 (.33)
127 mm (5")	8.44 (.68)	6.46 (.52)
190.5 mm (7.5")	24.34 (1.96)	22.35 (1.80)
203 mm (8")	28.19 (2.27)	26.20 (2.11)

Multiply applicable quantities times depth of hole in m. A 20% margin has already been included in the above scale.

All quantities are in L/m. (Gal./ft.).

GROUT MIX CHART FOR SLOPE INDICATOR Mix is for 380 L (100 Gal.)				
Bentonite %	* Quick-Gel (L)	Cement (L)	Water (L)	Viscosity/1000 cc
5%	6.4 (1.7 Gals.)	119.7 (31.6 Gals.)	252.3 (66.6 Gals.)	34 sec.
10%	12.5 (3.3 Gals.)	113.6 (30.0 Gals.)	252.3 (66.6 Gals.)	34 sec.
15%	18.9 (5.0 Gals.)	107.2 (28.3 Gals.)	252.3 (66.6 Gals.)	36 sec.
20%	25.4 (6.7 Gals.)	100.8 (26.6 Gals.)	252.3 (6.66 Gals.)	36 sec.

Note: Due to voids in powders, the mix will be decreased by 15 to 20% after mixing.

* Quick-Gel is brand name for high yield bentonite clay.

SLOPE INDICATOR LOG

Location _____ P.I.N. _____ D.H. # _____

Date Start _____ Date End _____

Station _____ Elevation _____

Core Recovery _____ % 1.5 m Depth of Hole into Till _____

	Depth Below Ground	Stick Up Above Ground
150 mm Collar Pipe and Cap	_____	_____
HW Casing to Till or Ledge	_____	_____
S.I. Casing plus Tip	_____	_____
Inside of S.I.	_____	_____

Grout

Quantity Mixed _____ L. _____ % Mix Used

Water _____ L. Cement _____ L. Bentonite _____ L.

Elevation of Grout Loss #1 Regrout Date _____

Elevation of Grout Loss #2 Regrout Date _____

Elevation of Grout Loss #3 Regrout Date _____

Comments in Hole Progression (Boulder Condition, Water Loss, Artesian Flow, Etc.)

_____

ALTERNATIVE SLOPE INDICATOR INSTALLATION

To install a 84.8 mm diameter (slope indicator), a 100 mm drive pipe or HW flush joint casing is driven or drilled into the depth indicated by the Soil Mechanics Bureau. If rock is encountered, a 1.5 m core should be taken to establish that it is rock. If the OD of the cored hole is less than 95.2 mm, a 95.2 mm roller bit should be used to open the hole through the cored area. If the rock is very hard, an appropriate size diamond bit can be used.

The grout, typically a 15% by volume Bentonite grout, is then mixed using the mix charts available at the Soil Mechanics Bureau. It is mixed by adding cement to water first and then adding the bentonite while circulating the mixture through a centrifugal pump or other suitable pump until it is thoroughly mixed. A quantity of about 12 liters of grout per meter of hole is usually sufficient material for this purpose but that may vary more or less in different soil conditions. This method is not to be used in soils with a high void ratio as the grout is thin as originally mixed. Slope indicators placed in areas with a high void ratio or holes that have areas where drilling fluid or water are lost have to be treated individually due to the great variety of conditions that can exist. The Soil Mechanics Bureau will assist.

The grout is then pumped down through the drill rods or through a hose placed in the hole. It should be discharged at the bottom of the hole. Pumping is stopped when the water is expelled from the hole and the grout has filled the hole. The drill rod or grout hose is then removed.

A cap is glued to the bottom of the first piece of Slope Indicator pipe and a coupling glued to each piece that is to be joined in the string. Four lines are drawn on the outside of the Slope Indicator coupling to locate the grooves on the inside. If the self aligning couplings are used, the sections of Slope Indicator pipe are pop riveted or glued together with 4 rivets and tape is placed at the joint and over the rivets. If the couplings are not self aligning, an aligning tool with 3.66 m of light line attached is placed in the grooves so that half of the tool is sticking out. This is placed in the grooves of the preceding length of pipe and the coupling pushed down over the end of the Slope Indicator pipe in the hole. The pipe is then riveted and taped. Care should be taken to place the rivets between the lines that mark the

grooves and about 25 mm above the bottom of the coupling. The Slope Indicator is then pushed into the hole and the aligning tool is withdrawn. As the Slope Indicator pipe is placed in the hole it becomes buoyant, so water is placed inside to make it less buoyant and easier to push into the hole. When the Slope Indicator pipe is at the bottom of the hole, enough Slope Indicator pipe is added or removed to allow the Slope Indicator pipe to stick up approximately 600 mm above the surface of the ground.

The Slope Indicator pipe must be further weighted and plugged while withdrawing the casing. A simple way is to attach a 95.2 mm roller bit and sub to a length of NW rod, plug the discharge ports and insert it upside-down into the Slope Indicator pipe. Seal the bit sub to the Slope Indicator pipe with tape. The Slope Indicator pipe is then aligned in the hole with one set of grooves set up and down slope in the direction of the slide. This is not critical as there is occasionally movement when the pipe or casing is removed from the hole. The drill pipe or casing is then removed from the hole. refilling the hole with grout as each 1.5 m piece of casing is removed. If the alignment of the Slope Indicator grooves has changed while the pipe is being removed, no attempt should be made to realign them. A short length of 150 mm plastic pipe with a stab to 150 mm male pipe thread fitting on top is then placed over the Slope Indicator pipe, hand dug into the ground and grouted in place.

The inside of the Slope Indicator pipe is then flushed out with water until any foreign matter that may be in it is removed. The Slope Indicator pipe is then held in place until the grout sets.

A protective cap is needed. A length of 150 mm plastic pipe long enough to cover the Slope Indicator pipe is fitted with a 150 mm stab to female fitting on one end and a 150 mm plastic pipe cap glued on the other.

This is screwed onto the piece in the ground.

The water level should be checked in the Slope Indicator pipe and if necessary lowered to a depth that will be safe from freezing.

The hole should be checked on the following day and if the grout has settled, clean

sand should be air dropped into the space between the Slope Indicator pipe and the 150 mm pipe until it is filled to the ground surface. The Instrumentation Section of the Soil Mechanics Bureau is then notified so that necessary elevations and readings can be taken. A log of the Slope Indicator hole is provided by the Region for Main Office files.

SUBSURFACE EXPLORATION AND INDIVIDUAL
SOIL SAMPLE IDENTIFICATION SYSTEM
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

JUNE 1994

IDENTIFICATION OF SUBSURFACE EXPLORATIONS

The following abbreviations and symbols are to be used to identify all subsurface explorations and all State projects:

Type of Exploration	Abbreviation	Symbol (on plans)
65 mm Cased Drill Hole	DA	
100 mm Cased Drill Hole	DN	
Hollow Flight Auger	FH	
Drilling Mud	DM	
Power Auger	PA	
Hand Auger	AH	
Dutch Cone Penetrometer	CP	
Probe	PH	
One Inch Sampler (Retractable Plug)	RP	
Test Pit	TP	
Percolation Test Hole	PT	
Seismic Point	SP	

(The abbreviation PA is to be used for borings progressed with augers having solid stem or single helix.)

The subsurface explorations in the DA, DN, FH, and DM category shall further be identified by the following:

Abbreviation	For
B	Bridge
C	Cut
D	Dam
F	Fill
K	Culvert
W	Wall
X	To be used if one of the above designations cannot be defined at the time the exploration is made.

NOTE:

1. Each exploration shall be numbered sequentially. However if a planned exploration is not made, a gap in consecutive numbers is permitted.

2. If a boring is abandoned prior to reaching the required depth, the logs for the adjacent continuation hole should be designated with a lower case letter, starting with 'a', added to the hole number.

3. The name of the structure, the road crossing, the stream, river or creek shall be shown in the space between the heavy and light borders on the bottom of the log.

   For example:

   Mainline Southbound over Morris Road

   West Avenue over Penn Central

   Culvert at Roaring Brook

SUMMARY

Examples of proper boring identification:

DA-C-1 This is a 65 mm diameter boring progressed for a cut.

DN-B-2 This is a 100 mm diameter boring progressed for a bridge.

IDENTIFICATION OF INDIVIDUAL SOIL SAMPLES

Each jar, tube, bag or other container shall be identified by the following:

1. PIN

2. Exploration Number

3. Individual Sample Number

A typical sample number would be 3102.00-DA-B-1-J1. This number identifies the first jar sample from a 65 mm boring designated as DA-B-1 on project number 3102.00.

The abbreviation J is used for jars and T is used for tubes. The J and T refers to the container that the sample is in when it leaves the field. If a tube is pressed and the soil is put into a jar it would be a "J" sample.
NOTE: Number all samples in each exploration consecutively, I.e., J1, J2, T3, J4, T5, etc.

Sample label below:

SM 251d(11/78) SOIL MECHANICS BUREAU				TOP
REG PIN		HOLE NO.		SAMPLE
PROJECT				AMT PRESS
STATION	OFFSET	SAMPLING DEPTH		AMT RECOVER
		FROM	TO	
REMARKS:				

Jar samples are to be transported in partitioned cardboard boxes.
Each box is to be identified with a properly filled in label.
Form SM 236a (3/66). A label is to be attached to <u>each</u> end of the box.

Only one project can be transported per carton.

SM 236a (1/72) **JAR SAMPLES**

PROJECT		DATE
REG.	COUNTY	LAB. NO.
HOLE NO.	SAMPLE NOS.	TO
HOLE NO.	SAMPLE NOS.	TO
HOLE NO.	SAMPLE NOS.	TO

PROCEDURE FOR PROCESSING SOIL SAMPLES

I. General

All soil samples are to be described according to STP-2, "Soil Description Procedure."

All reference in the following paragraphs to completion of the final subsurface exploration log and disposition of the soil samples assumes that rock samples are processed according to existing procedures and retained at the Regional Laboratory for display to prospective bidders.

II. Procedure to be followed for all Subsurface Explorations Except Undisturbed Sample Drill Holes

Sample Drill Holes

1. The driller will obtain the soil sample, record all pertinent information, including the preliminary soil descriptions, on Form SM-208, or equivalent, place the soil sample in a plastic bag, seal the bag with a twistem, and then place the sealed sample into a properly labeled container.

2. The soil samples will be transported as soon as possible to the Regional Soils Laboratory. The soil samples shall not be allowed to freeze.

3. Upon completion of the subsurface exploration, the completed SM-208 or equivalent, will be delivered to the Regional Soils Laboratory.

4. The Regional Laboratory Technician will transfer all information, except the driller's soil description, from Form SM-208, or equivalent, to a draft copy of the SM 282e form or other appropriate form.

5. The Regional Laboratory Technician will then do the soil descriptions of the soil samples and other appropriate laboratory tests and record the

results electronically on the subsurface exploration log, SM-282e or other appropriate form.

On soil samples known to be destined for the Soil Mechanics Bureau, only a soil description and moisture content test will be performed. No other laboratory testing is to be conducted in the Regional Laboratory.

Moisture content tests will be performed on all mixed -grain, fine-grained and organic soils.

It is stated in STP-2 that "Classification tests are not intended to be used to verify the visual description." It is emphasized that no laboratory testing it to be done for the purpose of describing a soil sample.

6. The subsurface exploration log will be checked by the Regional Soils Engineer for completeness and accuracy. The final copy will be neatly hand printed or typed and will include the name of the laboratory technician.

   The final copy of the log will be proofread by the staff and the signature of the Regional Soils Engineer will be electronically entered.

   Copies of the final log will be made and distributed. Any draft copies of the log will be discarded.

7. The original copy of Form SM-208 or equivalent, will be discarded by the Regional Soils Engineer no later than the actual project PS&E submission data. This applies to all subsurface explorations.

   Two copies of either a preliminary log or the final log for each individual subsurface exploration will be forwarded to the Soil Mechanics Bureau within two weeks after the completion of the exploration. Preliminary logs will be marked "Preliminary." The final log will be forwarded as soon as the missing data is available.

8. All samples scheduled for delivery to the Soil Mechanics Bureau will be forwarded in properly labeled boxes within two weeks after completion of each subsurface exploration. Soil samples on selected projects may have to be forwarded in less than two weeks to meet predetermined time schedules.

III. Procedure to be followed for all Undisturbed Sample Drill Holes

1. The driller will obtain soil samples according to the approved procedure and record all pertinent information on Form SM-208, or equivalent, including the driller's soil description.

2. All preparations for undisturbed sample shipment will be done in the field. Samples in driven liner tubes will be processed similar to undisturbed samples.

   Samples shall not be allowed to freeze.

3. All samples will be delivered to the Regional Soils Laboratory as soon as possible. Undisturbed samples are to be stored vertically.

4. The Regional Laboratory Technician will transfer all the information, except the driller's soil description from the SM-208, or equivalent, to the draft copy of the subsurface exploration log, SM-282e.

5. The Regional Laboratory Technician will do the soil description and moisture content test for all soil samples, except driven liner tubes and record the results on the draft, SM-282e form. No other laboratory tests are to be conducted in the Regional Laboratory.

   If an undisturbed sample is indicated on the SM-282e form, the Regional Laboratory Technician will place the following note in the soils description column, "The soil description of all undisturbed soil samples are recorded on Form SM-401, Undisturbed Sample Summary Log."

The Soil Mechanics Bureau will do the soil description and moisture content test for all undisturbed soil samples.

A copy of Form SM-401 will be returned to the Region within two weeks of completion of the log by the Soil Mechanics Bureau.

6. The draft copy of the subsurface exploration log will be checked by the Regional Soils Engineer for completeness and accuracy. The final copy will be neatly hand printed or typed and will include the name of the Laboratory Technician.

   The final copy of the log will be proofread by the staff and the signature of the Regional Soils Engineer will be entered. A stamped or typed name will not be acceptable.

   Copies of the final log will be made and distributed. The draft copy of the log will be discarded.

7. The original, or a copy of Form SM-208, or equivalent, shall also be forwarded to the Soil Mechanics Bureau with the undisturbed samples. This form will be returned to the Region with a copy of Form SM-401, prepared by the Soil Mechanics Bureau.

   The original and copies of the SM-208 form, or equivalent, will be discarded by the Regional Soils Engineer no later than the project PS&E submission date.

   Two copies of either a preliminary log or the final log for each undisturbed sample drill hole will be forwarded to the Soil Mechanics Bureau within two weeks after completion of the exploration. Preliminary logs will be marked "Preliminary". A copy of the final log shall be forwarded as soon as the missing data is available.

8. All samples will be delivered to the Soil Mechanics Bureau, by State personnel only, within two weeks after completion of each undisturbed

sample drill hole.

9. Soils descriptions and appropriate laboratory testing will be done in all undisturbed samples at the Soil Mechanics Bureau. The results will be recorded on Form Sm-401, Undisturbed Sample Summary Log. The laboratory Supervisor will review the information on the form for completeness and accuracy and sign it.

   Copies of Form Sm-401 will be distributed to the Regional Soils Engineer, prior to the actual project PS&E submission date. This data must be made available to the bidders.

TO: J.C. Reagan, Associate Soils Engineer, 7A-116

FROM: D. Dwyer, CE II, 7A-116

SUBJECT: SUGGESTED QUANTITIES OF SAFETY EQUIPMENT PER REGION AND PER CREW, IN METRIC

DATE: September 9, 1994

This memorandum converts Leo Charbonneau's recommendations for quantities of safety equipment, dated March 19, 1985, to metric.

Each crew should have the following equipment:

1.	Stop/Slow paddles	2
2.	"No Shoulder" sign 1 m x 1 m	1
3.	"End Roadwork" sign 1 m x 600 mm	1
4.	"Men Working" sign or equal symbol 1 m x 1 m	1
5.	Flag Tree	1
6.	600 mm Cones	20

The formula for capacity of traffic cones is as follows:

Width of pavement in meters x speed of traffic (kph)÷1.6 = distance of coning before work area (cones to be 7.5 m to 15 m apart)

The quantity stated will allow each crew enough equipment to work on the shoulder of the road.

The following list of equipment should be attached to the soils group in each Region in excess of what is stated per crew.

1.	"Men Working" or equal symbol 1 m x 1 m	1
2.	Flag Tree	1
3.	Cones	20
4.	"Flagman Ahead" or equal symbol 1 m x 1 m	2
5.	"One Lane Road Ahead" 1 m x 1 m	2

The signs can be ordered from the Hamburg Sign Shop on requisition number TE38b (4/75).

DFD:NLW

FIGURE 302-9
EXAMPLES OF TRAFFIC CONTROL AT SHOULDER AND SLOWLY MOVING WORK AREAS

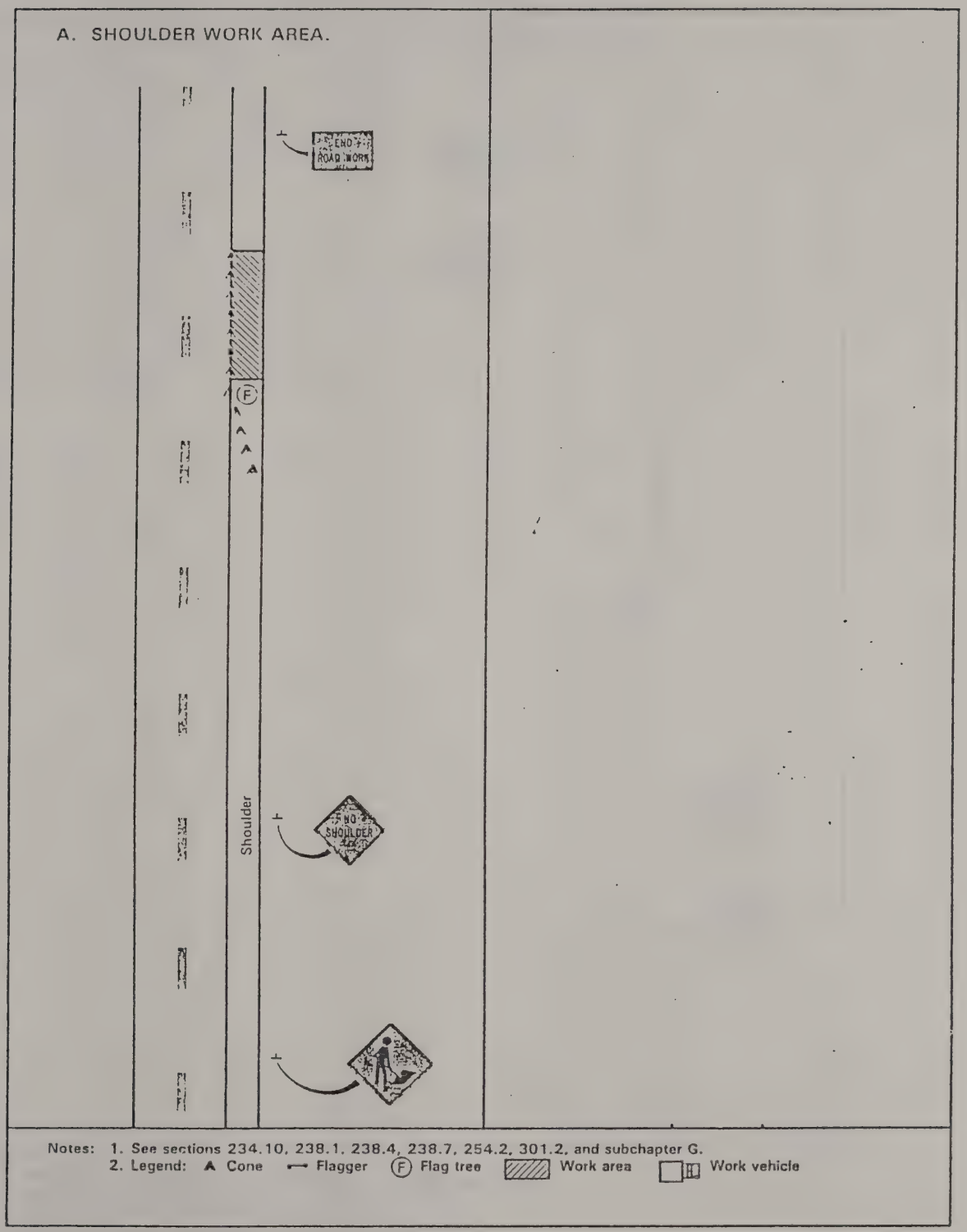
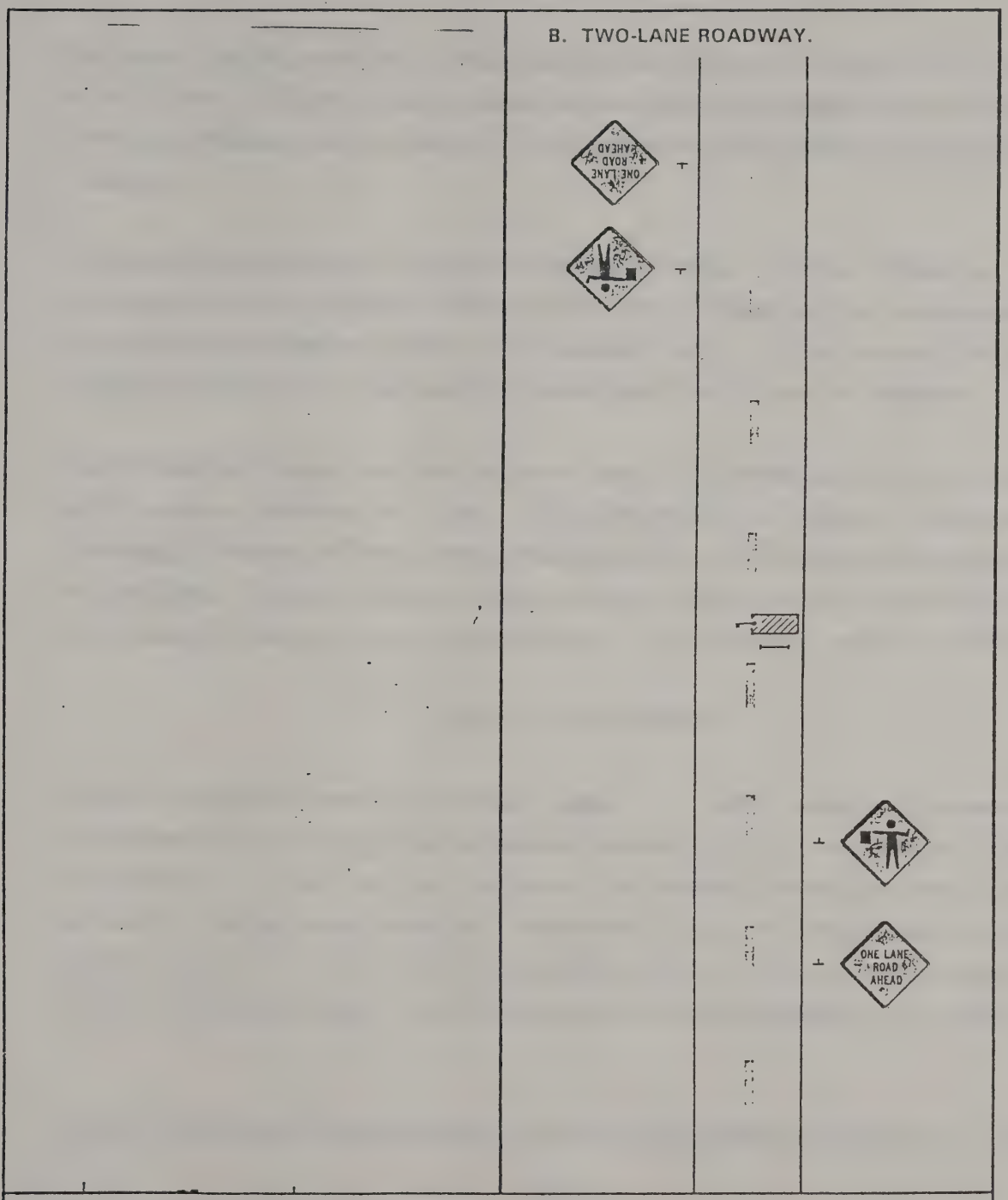


FIGURE 302-18
EXAMPLES OF TRAFFIC CONTROL AT SMALL SHORT DURATION WORK AREAS ON LOW-SPEED ROADWAYS



Notes: 1. See sections 238.4, 238.7, and subchapter G.
2. Legend: Barricade Cone Flagger Work area
3. L approx. = Transition length (see section 262.22).

TIPS FOR WORKMEN

Workmen applying calcium chloride should wear rubbers, rubber boots or rubber soled shoes. Calcium chloride absorbs moisture from leather shoes and gloves causing shrinking and cracking. Keeping leather well oiled helps prevent such damage.

Calcium chloride does not injure clothing or fabrics. It does, however, form a wet spot that will not dry out like spot of water. Rinse out the calcium chloride with plain warm water and allow the clothes to dry. Do not use soap to remove calcium chloride, as it will leave a greasy spot that is hard to remove.

Individuals with sensitive skin may develop a slight irritation from direct contact with calcium chloride solution. This condition is usually eliminated by thoroughly rinsing affected areas with plain water. If irritation persists consult a physician. Calcium chloride in the eyes may cause irritation and tears. Rinse with plenty of water to stop the irritation. If it is severe, consult a physician.

CARE OF EQUIPMENT

Calcium chloride does not corrode metals. It will, however, increase the incidence of rust on unprotected metals because it clings to the metal instead of evaporating. Rust may be minimized by normal preventive maintenance, including rinsing equipment with water after use and regular lubrication of moving parts. In tank trucks a quantity of oil may be floated on top of the calcium chloride solution to coat the insides of the tank as the solution level falls.

Do not use calcium chloride as an antifreeze in the cooling system of cars, trucks

and other vehicles. It will result in galvanic corrosion completely damaging the cooling system.

Tailgate Safety Training Topics

November 1986 Vol. I - 6 - 1

How To Lift And Carry

- Get a good footing.
- Make certain there are no tripping hazards on the floor.
- Place feet shoulder-width apart, one foot slightly ahead of the other.
- Bend at the knees to grasp the weight.
- Keep the back as straight as possible, but also at a comfortable angle.
- Get a firm grip on the object.
- Keep the back as upright as possible.
- Lift gradually by straightening the legs - don't jerk the load. Sudden movements, twisting or turning can cause injury.
- When the weight is too heavy, bulky, or awkward to lift comfortably, get help.

MAINTENANCE MANUAL • OPERATING INSTRUCTIONS • PARTS LIST

This manual is made up of three parts. Part No. 1 covers general instructions which apply to all types of core drilling machines. Part No. 2 consists of operating and lubrication instructions and Part No. 3 is the Parts List for the specific type of core drilling machine designated on the cover sheet.

PART NO. 1 GENERAL INSTRUCTIONS

GASOLINE ENGINES

All Gasoline engines have five basic requirements which, when met, will provide a long and economical life. These requirements are Oil, Air, Fuel, Ignition, and Cooling.

OIL

Most four-cycle engines (drill engines, pumps, and the like) have an oil pump, or reservoir, and make use of either a pump or splash system to distribute the lubricating oil to their moving parts. It is extremely important, therefore, that the proper oil level be maintained at all times. It is also important that the oil in all four-cycle engines be changed from time to time. Skipping oil changes is nothing more than false economy, because oil becomes contaminated with water, gasoline, carbon, acid and dirt. It is these contaminants in an engine's oil that does the damage. The oil in all four-cycle engines should be changed after each 96 hours of operation.

Two-cycle engines (outboard, chain saw, and other similar engines) have the lubricating oil added to the fuel. The manufacturer's specifications regarding

the amount and weight of oil to be added to the fuel **must be followed**. CAUTION: A two-cycle engine must never be fueled without the required oil mixture.

AIR

All gasoline engines require an ample supply of clean air, if they are to function properly. For that reason, pay particular attention to the air cleaner. The air cleaner is an important part of any engine, simply because gasoline will not burn properly without ample air. The cleaner also filters the air and in so doing helps to reduce the wear on the cylinder walls and bearings.

All air cleaners should be removed and washed in kerosene or fuel oil, and then dipped in clean oil and replaced every time the engine oil is changed. NOTE: In addition to its cleaning function the air cleaner is also a sort of safety device in that it can prevent a fire which might result from a backfire or from a flooded carburetor.

FUEL

All gasoline engines require clean, water-free fuel. Before trying to start any engine, always check the fuel level and the sediment bowls. If water or dirt can be seen in the sediment bowls, drain them before starting. NOTE: Some models of carburetors have a drain plug for this purpose.

IGNITION

The fuel used in all gasoline engines is fired by an electric spark. The spark originates from a battery or magneto, then timed by breaker points, and finally delivered to each cylinder by wires and spark plugs. Moisture, dirt, carbon,

or oil can easily ground or short circuit the electric current. It is important, therefore, that all of the parts involved by kept clean and in good working order. For example, the breaker points must open and close properly, and the spark plugs must be kept clean and properly adjusted. (NOTE: Spark plugs sometimes appear to be in good condition but fail because of internal resistance or partially burned electrodes within the plug). To deliver the proper electric spark, the entire electrical system of an engine must be properly adjusted and timed and kept clean and dry.

COOLING

There are two ways of cooling gasoline engines - with liquid and with air. Most liquid-cooled engines use water as the cooling fluid. These engines are generally protected from freezing by the use of anti-freeze or they may be drained periodically during extended cold weather periods. Air-cooled engines must have operative fans and clean cooling fans to provide trouble-free service. Any engine without the proper cooling protection can quickly be turned into a piece of junk through excessive heating or freezing.

STARTING TIPS

The first points to check when an engine refuses to start are the fuel tank, fuel lines, and carburetor drain. You can make sure that fuel is being delivered to the carburetor by disconnecting the line at the carburetor and allowing the fuel to run from the tank a few seconds. NOTE: Do not fool with the carburetor adjustments; the troubles could be increased if these adjustments are altered in any way.

Assuming that fuel is being properly delivered, pull a wire off a spark plug

and check the spark when the engine is turned over. If there is no spark, remove the magneto or distributor cover and check the points. Make sure that they are adjusted properly and that they are completely dry. Moisture can be a menace at this point. If, after checking the points there is still no spark, check the magneto, battery, coil and condenser. Make sure these parts are all in good working condition. Replace any or all of them, if necessary. NOTE: When changing a magneto, make sure that the timing marks on the new magneto drive gear line up the same as the old magneto drive gear, and that the wires to the spark plugs, switches, and so forth are in the same sequence.

If spark is delivered to the spark plugs but the engine does not fire, remove the spark plugs, clean and dry them out, and then replace them. Make sure that they are adjusted properly.

NOTE: Many drillers heat the removed spark plugs over a small fire or with a propane torch, and then add several drops of oil to each cylinder before replacing the plugs. The oil helps to increase the compression and makes it easier for the engine to start.

If all possible sources of trouble have been checked and the engine still will not start, check the carburetor. If repeated choking does not indicate a flooded carburetor when the air cleaner is removed, take the carburetor off and either repair it or replace it. NOTE: Make sure that all gaskets are tightly sealed, or poor performance will result. A light coating of grease on the gaskets helps to assure a tight seal.

If the weather is extremely cold and the engine is very stiff, drain the engine oil, heat it slightly, and replace it. It may also be helpful to do the same with the cooling fluid. CAUTION: Never have open flames or torches around gasoline

engines.

DIESEL ENGINES

Basically, diesel engines are very similar to gasoline engines. Diesel engines, however, have no electrical ignition system. In order to operate efficiently, diesel engines must have Lubricating Oil, Clean Air, Clean Fuel, and Sufficient Cooling.

OIL

Most diesel engines have an oil pump and make use of a pump or splash system to distribute the lubricating oil to their moving parts. The proper oil level must be maintained at all times. Also, the oil and oil filters should be drained and replaced from time to time.

As previously noted, because of the nature of the fuel used, diesel engines require the best grade of oil available - Series 3 supplement oil is recommended. SAE 30 is recommended for use in summer and SAE 10 to 20 in winter. Maintain proper oil levels and change oil and filters as recommended.

AIR

All air filters should be kept clean. They should be serviced from time to time, using the same procedure outlined for gasoline engines.

FUEL

Always maintain an adequate supply of clean fuel of the correct grade in the

fuel tank. If air should get into the fuel injection system of a diesel engine, it is sometimes extremely difficult to "bleed" out and the engine will not operate until it is removed.

Since water or dirt can be extremely damaging to the injection system of a diesel engine, filters are provided, and if properly serviced, these will thoroughly clean the fuel. As previously recommended, it is good practice to drain the filter bowls at the end of each shift. The filter elements, however, are designed to absorb minute particles of water, and if not changed regularly, these can become so water-clogged that fuel will not pass through them.

After changing fuel filters, or sometimes due to broken fuel lines or running out of fuel, it will be necessary to "bleed" the fuel system to get rid of any air which may have entered. Vents located on the filter bowls and sometimes near the injectors should be loosened, the engine rotated or the fuel pump worked by hand, until all air has escaped and fuel has reached the vents. When priming has been completed, all vents and/or lines must be closed and tightened.

IGNITION

The fact that the fuel mixture in a diesel is not fired by an electrical spark is no reason for ignoring the ignition system. Basically, the ignition system is simple. The diesel fuel is injected into the cylinder just before the cylinder reaches its full compression stroke. As additional compression is applied, the mixture of air and diesel fuel heats up. Ignition of the mixture place, when enough heat and pressure have been applied, as the cylinder makes its compression stroke. To insure proper and economical operation, the fuel must be injected in proper amounts at the proper time, and under the proper pressure. Repairs to the fuel injection system should be made by an experienced

mechanic only.

COOLING

A diesel engine must always have simple cooling fluid and the fan, water pump, hoses, and radiator must be in good condition. Air-cooled units must be kept clean and properly shrouded. A diesel engine without the proper cooling protection can become a piece of junk as quickly as a gasoline engine.

STARTING TIPS

Most diesel engines you will use will be equipped with electric starting motors. As most of these engines are "full diesel", that is, they rely on heat generated by compression for the ignition of the fuel charge, they will sometimes seem more difficult to start than gasoline engines, especially in cold weather. This is not true, and if the engine is in good repair and properly serviced, and correct starting procedures are followed you will find the diesel to be much more reliable than the gasoline engine.

The storage battery must be kept at full charge. Faulty generators or batteries which will not maintain a charge should be corrected.

Become familiar with the engine you are using. Many have starting aids which help greatly, especially in cold weather. These aids may be intake air heaters, or glow plugs. Some have ether injectors on them. The use of these aids will make starting much easier.

If equipped with electric air heater or glow plugs, depress heater button for approximately ½ minute. Be sure the decompression, or shutoff lever, is in the

"run" position, and open throttle about half-way. Engage starter, and engine should start. If it does not start within one minute, disengage starter and repeat the process.

Should two or three attempts fail, or if engine is not equipped with a heating unit, the use of starting fluid is recommended. With Starter Engaged, spray starting fluid into the air intake of the engine in small amounts. Too much starting fluid will cause preignition and engine will not turn over. After it begins running, in may require an additional short spray or two until enough heat is developed to cause fuel ignition.

CAUTION: Do not attempt to use both an intake air heater and starting fluid. Dangerous explosions can result.

The use of winter-grade lubricating oil is a must for cold weather operation, and during severe weather, preheating of the crankcase and block may be necessary.

Diesel engines should never be allowed to idle or lug slowly under load for long periods. To do so can cause excessive piston and piston ring and bearing wear or damage. If a diesel engine is properly maintained and if clean fuel, air and lubricating oil are used, it will give years of trouble-free service.

AIR MOTORS

Air motors are relatively simple to operate and have but two basic requirements for long and efficient service - lubricating oil and clean and dry compressed air.

OIL

Some piston type air motors have both in-line and sump lubricating systems. The in-line oiler is generally located in the air supply line and about ten feet from the motor. The oiler must be filled after every four hours of operation. NOTE: Some in-line oilers must be kept in an upright position. CAUTION: Make sure that the air supply valve is off and the line pressure is relieved before refilling the oiler.

The oil sump is located at the bottom of the air motor just as it is on a gasoline engine. The sump oil level should be kept filled to the top outlet. If water has accumulated in the oil, it should be drained through the bottom outlet. The sump should be checked daily for such accumulation. Non-detergent oil should be used.

Vane-type air motors, often used to drive small machines, are lubricated by in-line oilers and require the same type of servicing as given for piston-type air motors. Air motors generally use regular SAE 30 motor oil in the summer and regular SAE 20 motor oil in the winter.

COMPRESSED AIR

For efficient trouble-free operation, a compressed air motor needs a good supply of clean air supplied under 620 to 700 kPa line pressure. NOTE: Some mine air supply lines may not provide the required pressure.

Before connecting or starting an air motor, make sure the air line is opened and all dirt and water is blown out. CAUTION: Never direct an air blast toward anyone; foreign particles may be discharged and cause serious injury. Check

the air cleaners and screens for dirt from time to time; clean them, if necessary.

If there is excessive moisture in the air supply, use a receiver tank and bleed the water out of this tank periodically.

LACK OF POWER CHECKPOINTS

The first thing to check, if an air motor fails to develop proper power, is the air supply. Make sure there is from 620 to 700 kPa of pressure in the line and that the proper volume of air is being delivered.

Check the strainer for any accumulation of dirt or trash.

Bleed the air receiver tank and blow out the supply line to eliminate any water in the line; also, drain any water from the oil sump.

Check the in-line oiler; the motor may not be receiving enough oil.

Check air line hook up to the motor. Make sure that the inlet and exhaust lines have not been reversed or that excessive leaks are not evident.

Check for excessive frost or ice building at the exhaust port. The use of an approved anti-freeze solution in the air may be required.

If after making all these checks there is still insufficient power, the motor may need to be overhauled or it may need other repairs. If this is the case, the motor should be serviced by an experienced mechanic.

HYDRAULIC SYSTEMS

Most Hydraulic systems will provide long and trouble-free service if a few basic requirements are met. Hydraulic systems require ample fluid, tight connectors, cleanliness, and proper adjustment and lubrication.

AMPLE FLUID

All reservoirs of hydraulic system must be kept full at all times. Only clear and water-free hydraulic oil should be used. Recommended brands include Sinclair's Sinterline "B", Standard's (ESSO) Stanoil #21, Gulf's Gulfcrest "A", Texaco's Regal "A", and Atlantic's Ideal "D". SAE 10 motor oil can be used in emergencies, but it is not recommended for continued usage because it has a deteriorating effect on rubber hoses, seals, and packing rings.

TIGHT CONNECTIONS

All hydraulic lines, valves, fittings, and the like must be air tight to assure constant pressure.

CLEANLINESS

When any part of a hydraulic system is disassembled or repaired, absolute cleanliness must be exercised. Hydraulic pumps, valves, and fittings are made to function with very close tolerances and a very small amount of foreign substance can easily cause trouble in the system.

ADJUSTMENT AND LUBRICATION

All drive chains, belts, and gears must be properly adjusted and lubricated at all times.

LUBRICATION INSTRUCTIONS FOR 40-CL HOIST OR DRAW WORKS

1. DRILL TRANSMISSION AND FRONT BRACKET

The fill, oil level and drain plugs are located in the transmission case on the opposite side from the transmission shift lever. (Cathead Side) The transmission case should be filled with SAE #90 gear lubricant until the lubricant shows in the oil level hole. In filling the transmission case the front bracket is also filled through matching connecting holes machined in both castings. The level in the transmission should be checked at regular intervals and lubricant added as required.

2. GREASE FITTINGS

The following grease fittings are provided and a multi-purpose bearing lubricant should be used for all lubrications. We recommend that lubricant be added approximately once every 3 shifts unless unusual working conditions dictate more frequent lubrication. Too much lubricant can cause bearings to run hot.

A. Thrust Yoke on Swivel Head

"NW" Size - Drawing No. A51200, Ref. No. 44

"HW" Size - Drawing No. A51270, Ref. No. 22

B. Top and Bottom of Swivel Head Body
"NW" Size - Drawing No. A51200, Ref. No. 15
"HW" Size - Drawing No. A51270, Ref. No. 21

C. Clutch Housing Bearing

D. Clutch Pilot Bearing

E. Clutch Release Sleeve
Above on Drawing No. A40418, Ref. No. 39, 45, 46

F. Pillow Block Bearing on Power Take-Off Shaft
Drawing No. A40421, Ref. No. 18

G. Main Transmission Shaft
Drawing No. A40100, Ref. No. 102
Drawing No. A40100-1, Ref. No. 102

H. Drum Shaft (Center of Rear Bracket)
Drawing No. A40100, Ref. No. 108

I. Planetary Pins (Fittings inside of rear bracket, cut-out provided in rear bracket casting, marked with brass plate).

J. Guide Roller for Wire Rope
Drawing No. A40396, Ref. No. 4

K. Six fittings are provided, 3 on each side of the sliding base on units having hydraulic retraction. These fittings provide for lubrication between the sliding base and the skid frame and lubricant should be added frequently.

L. Grease fittings are provided on each of the 7 guide sheaves which are used with the wire cable for moving the unit under its own power. Lubrication of these sheaves will depend on the frequency of use.

M. Bevel gear in the swivelhead should be lubricated once every shift, using a good grade of open gear lubricant. Access to the gears is accomplished by loosening the hex nut on the eye bolt; swing the eye bolt clear of the slot in the swivelhead body casting. This allows the swivelhead to be swung open on the hinge pin, exposing the gears.

N. The silent drive chain is lubricated by means of a sight feed oiler using any good grade of SAE 30.

O. The drill spindle on the swivelhead should regularly be wiped clean and a coating of grease applied to its full length. This not only serves to lubricate the spindle but also prevents rusting.

STARTING SEQUENCE FOR 40-CL CORE DRILL MACHINE

PLEASE REFER TO PICTURE OF DRILL MACHINE WITH REFERENCE NUMBERS FOR THE VARIOUS OPERATING CONTROLS.

1. Disengage Main drill clutch by pulling clutch handle (4) toward the front of the drill.

2. Fully open the hydraulic pressure control valve (5) by turning handle in a counter clockwise direction.

3. Fully close the swivelhead feed control valve (6) by turning handle in a clockwise direction.

4. Move the transmission shift handle (9) to the neutral position.

5. Move the swivelhead and cathead-hoist shift lever (10) into the neutral position. The lever arm should be parallel to the skids in the middle notch.

6. Pull down on the hoist brake lever (2) until it locks.

7. Raise the hoist clutch lever (1) to a verticle position to release tension on the band.

8. Check to see that the hydraulic retraction control valve (7) is in the neutral position - (See separate drawings on shifting patterns for various controls)

9. Check to see that the swivelhead directional control valve (8) is in the neutral position - (See separate drawing on shifting patterns for various controls)

When the above procedure has been completed the engine or power unit can be started using normal practice for the type of power unit on the drill.

After the engine has been started and allowed to warm up sufficiently the following check procedures can be completed.

1. With the transmission in neutral, engage the main drill clutch by pushing the clutch handle forward toward the engine until it snaps in. This is an over-center industrial type clutch that will remain engaged until it is manually disengaged.

2. The hydraulic oil pump should now be rotating, and the hydraulic retracting valve should be in the neutral position (this is automatic because the valve is spring loaded).

3. Move the swivelhead directional control valve (8) into the DOWN feed position. Slowly close the hydraulic pressure control valve (5) (This is commonly known as the by-pass valve) and observe the increase in pressure on the hydraulic pressure gauge (14). With the valve fully closed the gauge should register approximately 5500 kPa. The maximum pressure is dependent upon the speed of the drill engine. Next, open the hydraulic pressure control valve slowly and note the drop in the pressure. When the valve is fully open there should be no pressure registering on the gauge.

4. Close the hydraulic pressure control valve until the gauge shown approximately 700 kPa pressure. Now slowly open the swivelhead feed control valve (6). This is a needle valve which regulates the flow of hydraulic fluid out of the bottom of the feed cylinders on the stroke. Opening or closing this valve controls the rate of feed on the drill spindle either direction. Now move the swivelhead directional control valve (8) into the UP position and note the change in direction of travel of the drill spindle. Instant changes in direction can be made at any time and at any speed.

CAUTION: BEFORE ATTEMPTING TO USE THE HYDRAULIC RETRACTING SYSTEM THE OPERATOR MUST MAKE SURE THAT THE BOTTOM OF THE SAFETY CHUCK ON THE DRILL SPINDLE IS RAISED ABOVE THE LOWER ENDS OF THE HYDRAULIC FEED CYLINDERS. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN DAMAGE TO THE RETRACTING CYLINDER MECHANISM OR THE DRILL SPINDLE CAN BE BENT.

Return the swivelhead directional control valve (8) to the neutral position and close the swivelhead feed control valve (6) tightly,

5. On drill units having the hydraulic retracting feature the following check procedure should be followed.

   A. Remove the safety stop pin from the matching holes in the sliding base and the skid frame.

   B. If the unit has clamping blocks on the skids the bolts should be loosened to allow the sliding base to move freely along the top of the skids or runners. Care should be taken to keep the clamping blocks sufficiently tight to eliminate excessive play between the two assemblies.

   C. Some units have a "U" clamp around the inside top flange of the skid and there is no adjustment necessary.

   D. Move the hydraulic retracting control valve lever (7) into the retracting position and hold in this position. If the sliding base does not move it will necessary to close the hydraulic pressure control valve (5) slowly in order to increase the pressure in the retracting cylinder to effect

movement of the sliding base. Next move the hydraulic retraction control valve (7) into the forward position. Observe that the sliding base assembly moves forward into the drilling position. The hydraulic retracting feature makes it possible to clear the area around the drill hole when hoisting or lowering tools in and out of the hole without having to move the complete drill unit. This is a time saving feature and also prevents hole mis-alignment.

CAUTION: WHEN THE UNIT IS IN THE DRILLING POSITION THE SAFETY STOP PIN SHOULD BE INSERTED IN THE PROPER HOLE TO PREVENT ACCIDENTAL RETRACTION DURING DRILLING OPERATIONS.

6. The following check procedure should be followed with respect to rotation of the drill spindle on the swivelhead.

   A. Disengage the main drill clutch by pulling the clutch handle (4) toward the swivelhead.

   B. Be sure that the sliding base is in the forward or drilling position.

   C. Check to be sure that the swivelhead direction control valve (8) is in the neutral position.

   D. Fully close the swivelhead feed control valve (6).

   E. Move the swivelhead and cat-head-hoist shift lever (10) from the neutral position downward toward the skids until the lever arm engages the lower notch.

F. Using the transmission shift lever (9), shift the transmission into low or 1st gear. (See separate drawing on shifting patterns).

G. Pull engine throttle lever (3) towards the swivelhead slowly to increase engine speed to about $\frac{1}{4}$ of full throttle.

H. Engage main drill clutch. Drill spindle should begin to rotate.

I. Disengage main drill clutch and proceed to shift the transmission through all four gears, each time engaging the engine clutch and noticing the increase in RPM of the drill spindle as the gear ratios change. In 4th gear the drill spindle is turning at the same RPM as the drill engine.

7. The following check procedure should be followed with respect to operation of the wireline hoist and the cathead. (Note: The cathead is an optional item).

A. Disengage the main drill clutch.

B. Move the swivelhead and cathead-hoist shift lever (10) from the neutral position upward until the lever arm engages the upper notch.

C. Shift the transmission into 1st gear.

D. Pull the hoist brake lever (2) down until it locks over-center.

E. Check to be sure that the hoist clutch lever is in the verticle position.

F. Engage the main drill clutch and check to see that the cat-head is turning. The wireline hoist drum should not turn.

G. Disengage the main drill clutch, shift the transmission into a higher gear and note the increase in speed of the cathead.

H. Release the hoist brake lever (2) by lifting up on the handle.

I. Pull down the hoist clutch lever (1) and check that the drum is turning. The planetary design of the hoist is such that the operator can accurately control the rotation of the hoist by the amount of pressure applied to the hoist clutch lever. After some practice the operator can develop a feel for the hoisting operation to a point where he can, in effect, inch the cable upward. The same holds true with respect to the operation of the brake lever. When using the wire cable to move the drill under its own power the hoist clutch lever can be pulled down overcenter to lock it but the operator should be prepared to release the lever quickly if an emergency arises.

It is important that the operator repeat the check procedures as outlined in order to be completely familiar with all of the controls. It is well to note that disengaging the main clutch on the engine will stop all operations. Another emergency action which can be taken is to turn off the ignition switch on a gasoline engine.

ADDITIONAL PRECAUTIONS WHICH SHOULD BE OBSERVED IN THE OPERATION OF THE DRILL MACHINE

A. When using the wireline drum for hoisting or lowering tools in or out of

the holes; or when moving the unit under its own power there should **always be 3 full or "dead" turns of wire rope on the drum.**

B. When inserting a drill rod down through the drive rod or drill spindle of the swivelhead, care should be taken to center the drill rod in the chuck as accurately as possible. The chuck set screws (11) can be backed out and the jaws pushed toward the outside the chuck and then the chuck set screws are tightened sufficiently to secure the rod. If any slippage between the chuck and the rod develops, the chuck set screws can be tightened to a greater degree. It should be noted that the chuck jaws are considered an expendable item, subject to replacement when excessive wear is evident. Chuck jaws are replaced by removing the plate on bottom of the chuck.

C. The Model 40C or Model 40CL core drill can be moved under its own power using the wireline hoisting drum and the wireline cable. To accomplish this it is necessary to first remove the wireline cable from the drum. The cable can then be threaded through the guide sheaves on the frame, either under the swivelhead or the engine end. The cable next is threaded up between the two sheaves located directly beneath the drum. From here the cable goes over the outside of the guide sheave which is located on the right side of the drill (when facing the swivelhead) slightly below the drum. After passing over the guide sheave the cable should go around the drum 3 full turns before being secured in the socket recessed on the left side of the drum by means of set screws.

SPECIAL INSTRUCTIONS WITH RESPECT TO MAINTENANCE OF "NW" SWIVELHEAD. REFER TO DRAWING NO. A51200

Located on the top of each hydraulic cylinder is a packing gland (Req. No. 35) and a stuffing box (Ref. No. 31). The stuffing box is secured to the upper bracket by means of two hex nuts which are directly below the packing gland. Between the stuffing box and the upper bracket is a lead gasket. The operator should exercise due care to see that the nuts above the stuffing box are kept tight to prevent leakage.

Pressure is applied against the chevron packing in the stuffing box by means of two hex nuts on top of the packing gland. **CAUTION:** These two nuts do not need to be tightened excessively. In fact, if the nuts are tightened down too much the packing gland can be damaged. These nuts only need to the tightened sufficiently to prevent leakage around the piston rod. Care should be exercised to tighten both nuts on the packing gland evenly.

INSTRUCTIONS FOR FIELD INSTALLATION OF S & H HYDRAULIC CHUCK ON S & H "NW" OR "HW" SWIVELHEADS

NOTE: If hydraulic chuck is to be installed on competitive makes of swivelheads contact the factory for mounting information.

"NW" SWIVELHEAD - REFERENCE DRAWING NO. A51200

1. Remove socket head set screw, Ref. No. 46.
2. Remove lock nut, Ref. No. 45. This part is threaded left hand and must be turned clockwise to remove.
3. Remove bearing retainer, Ref. No. 41 by removing 4 hex head cap

screws and lock washers.

4. Remove ball bearing, Ref. No. 40.
5. Install bearing spacer, Ref. No. 77 (Not shown on Drawing No. A51200).
6. Replace ball bearing, Ref. No. 40.
7. Install bearing retainer, Ref. No. 78 (Not shown on Drawing No. A51200).
8. Remove hex nuts, Ref. No. 24 from upper end of piston rods. (On top of thrust yoke).

"HW" SWIVELHEAD - REFERENCE DRAWING NO. A51270

1. Remove drive rod bushing, Ref. No. 55, if one is used.
2. Drive out two spring pins, Ref. No. 20.
3. Remove lock nut sleeve, Ref. No. 19 (This part is threaded left hand and must be turned clockwise to remove.).
4. Replace lock nut sleeve with Part No. 51285.
5. Remove hex nuts, Ref. No. 43 and lock washers, Ref. No. 42 from upper end of piston rods. (On top of thrust yoke).

YOU ARE NOW READY TO INSTALL THE CHUCK

The chuck has been assembled for shipping purposes. It will be necessary to disassemble it, remove the chuck jaws and then reassemble the chuck. This procedure is outlined in the following 19 steps.

All Reference Numbers are found on Drawing A66200

NOTE: STEPS 2 THROUGH 14 COVER THE PROCEDURE NECESSARY ONLY WHEN CHANGING CHUCK JAWS.

1. Remove eight (8) hex nuts and lock washers. Ref. No. 11 & 12, holding together the upper and lower halves of the chuck with 11/16 wrench provided.
2. Remove upper half of body.
3. Remove three (3) socket head capscrews and lock washers, Ref. No. 22 & 23.
4. Remove bearing carrier, Ref. No. 21.
5. Remove top jaw return spring, Ref. No. 20.
6. Remove chuck jaws, Ref. No. 19.
7. Raise lower half of chuck body from jaw housing, Ref. No. 10, and head adaptor, Ref. No. 9.
8. Attach head adaptor Ref. No. 9 and jaw housing Ref. No. 10 to swivelhead drive rod. Again note lefthand thread. Head Adaptor must be turned counter-clockwise to tighten.
9. Place lower chuck body on top of thrust yoke. Make certain grease gun access is to the front of swivelhead.
10. Replace two (2) hex nuts, Part No. 4P144, and lockwashers, Part No. 5P14, on hydraulic rams.
11. Replace chuck jaws Ref. No. 19, and top jaws return spring Ref. No. 20.
12. Replace bearing carrier, Ref. No. 21 and socket head capscrews & lockwashers, Ref. No. 22 and 23.
13. Replace upper half of chuck body.
14. Replace eight (8) hex nuts and lockwashers, Ref. No. 11 & 12.
15. Remove guide bushing retaining ring, Ref. No. 36, using a screwdriver in the slot provided.

16. Install guide bushing of same drill rod size as chuck jaws and replace retaining ring.
17. Remove bottom plate, Part No. 51038, from manual chuck, Part No. 51037.
18. Remove standard chuck jaws. For reasons of safety, remove set screws, Part No. 51147, from manual chuck.
19. Replace bottom plate, Part No. 51038, with guide plate of same size as chuck jaws in hydraulic chuck.